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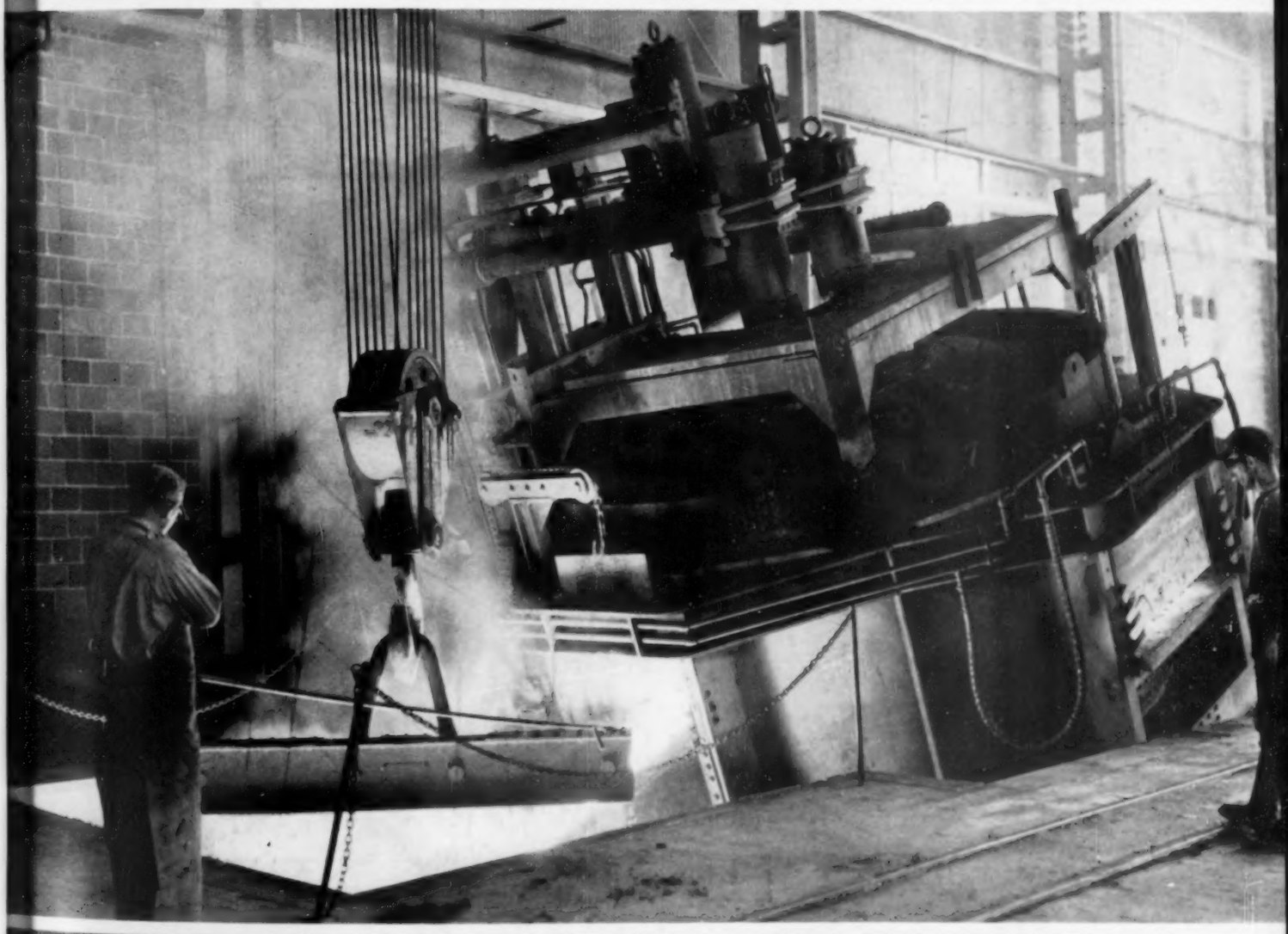
The WELDING Journal



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The Shotweld Process of Welding Stainless Steel "18-8"*

By Joseph Winlock† and J. J. MacKinney‡

RESEARCH has done much to reverse the adage that "the art precedes the science" but there are many industrial processes whose early successes were entirely dependent upon human ingenuity and personal skill. The proper temperatures for heat treating steel, for example, were, and in many cases still are, judged by the eye of a skilful workman, instead of by the accurate measuring instruments developed by research.

The purpose of this paper is to show how some of the problems connected with the resistance welding of metals and, in particular, stainless steel 18-8, have been approached by research work conducted in the laboratory and in the shop.

It was some forty or fifty years ago when it was found that two pieces of metal could be welded together by passing an electric current through them while being held together by two electrodes having high current carrying capacity. By this procedure actual melting or incipient melting was produced at the points of greatest electrical resistance, i.e., the interfaces.

Simple as are the essentials of this procedure, the qualitative and quantitative data necessary for its completely successful application in the joining of parts of highly stressed structures are extremely complicated. Not only is it necessary to know the amount of current needed to make the weld, but it is necessary to know, also, the interrelationship between the other variables and the effect of these relationships upon the quality of the weld. Some of these other variables are: the time of current flow, the pressure on the electrodes, the size and contour of the electrodes and the condition of the contact surfaces.

It is of fundamental importance to know, also, the effect of the welding operation on the physical properties of the metal in and around the weld. This is because in resistance welding no new and usually different metal is added to the weld as in arc welding. The properties of the weld metal in resistance welding are those of the metal being welded which has been heated to a very high temperature and cooled rapidly from that temperature. It becomes necessary, then, to consider weldability not only in terms of whether or not a metal actually can be welded, but also as to whether or not the metal in the weld has useful physical properties. A weld may, for example, be made of correct size, shape and appearance, but the weld metal itself may be so brittle as to be of little value.

Metallurgy of Stainless Steel 18-8

"18-8" is a generic name for one of the stainless steels containing approximately 18.0% chromium and 8.0% nickel. The range of the chemical composition of 18-8 is as follows:

Carbon	0.15% maximum
Manganese	2.50% maximum
Sulphur	0.03% maximum
Phosphorus	0.03% maximum
Silicon	1.5 % maximum
Copper	0.50% maximum
Nickel	7.00% minimum
Chromium	17.00% minimum

Due principally to the effect of the high nickel content and to the sluggish diffusibility of chromium, the alloy, as Aborn & Bain point out,[1] consists of a solid solution of the different constituents in gamma iron. For all practical purposes the alloy is a perfectly stable material, but the austenite being in an undercooled condition is from a physical-chemical point of view in metastable equilibrium. It is unstable in respect to its allotropic condition and in respect to carbon solubility. It has been shown, for example, that when this alloy is cold worked at room temperatures some of the gamma phase is transformed to the alpha phase. The extent to which this occurs is, of course, dependent not only upon the amount of cold deformation but also upon the amount of other alloys present.

It has been found, also, that when this alloy is heated to a temperature range below that at which the carbon is completely soluble, a precipitation of carbides takes place. This temperature range is approximately 900 to 1500° F. Under ordinary conditions, the precipitation of a phase such as this in an alloy does not markedly affect its resistance to corrosion and, indeed, the usefulness of many alloys depends upon a precipitation (aging of

* Presented at the Annual Meeting, A. W. S., Philadelphia, Pa., Oct. 20 to 24, 1941. Reg. U. S. Pat. Office.
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[1] Aborn and Bain, "Nature of the Nickel-Chromium Rustless Steels," *Amer. Society for Metals*, Vol. 18, p. 837.

Duralumin). In stainless steel 18–8, however, the precipitation of carbides is accompanied by a lowering of the corrosion resistance.

Figure 1 shows a photomicrograph of stainless steel cooled rapidly from 2000° F. Figure 2 shows a photomicrograph of annealed stainless steel in which carbides have been precipitated.

Because the austenite condition persists after cooling rapidly from high temperatures to room temperature, this steel cannot be heat treated in the ordinary sense, i.e., its properties cannot be materially changed by heat treating. Like most metals, its yield strength and tensile strength can be very materially raised by cold rolling, but unlike most metals it has the valuable property of retaining an unusual amount of ductility. When cold rolled to tensile strengths as high as 150,000 lb. per sq. in. elongations in 2 in. as high as 30.0% are not unusual. In light gage strip steel, tensile strengths as high as 190,000 lb. per sq. in. can be obtained with satisfactory ductility for bending, forming or draw rolling. As with other metals, subsequent heating anneals (softens) the steel, but even in the fully annealed condition the metal has a tensile strength of some 90,000 lb. per sq. in. with the unusually high percentage elongation of some 65.0% in 2 in.

These facts very clearly indicate that the proper use of this steel depends upon a knowledge of and a control of the lowering of its resistance to corrosion accompanying the precipitation of carbides. This control is of special importance if the steel is to be used for purposes where the component parts are welded. Uncontrolled heating obviously may occur if improper welding technique is employed.

The "Shotweld" process about to be outlined controls these phenomena to the end that the strength and the corrosion resistance of the finished structure are entirely unimpaired.

Fig. 1—Stainless Steel Cooled Rapidly from 2000° F.

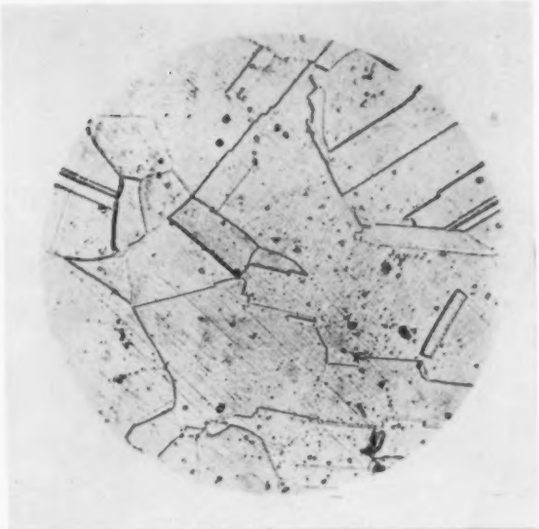
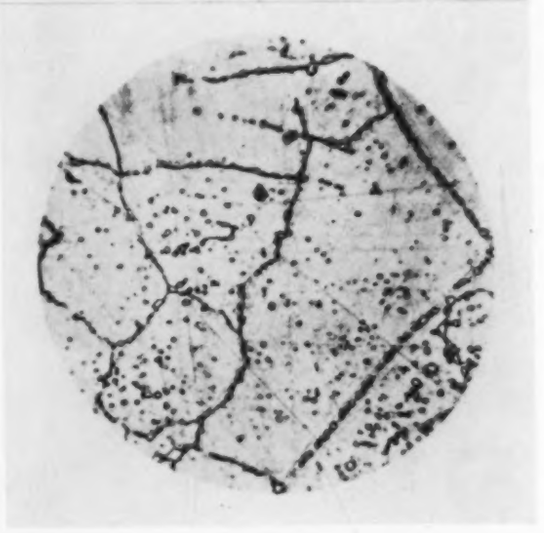


Fig. 2—Annealed Stainless Steel



Welding Process

The total heat delivered to a resistance weld is proportional to the r.m.s. current squared (which will be referred to hereafter simply as I^2), to the time of current flow, t, and to the resistance, r, between the welding electrodes. If the pressure on the electrodes, the shape and the alignment of the electrodes, and the condition of the surface of the metal being welded are absolutely uniform, the resistance between the electrodes will be constant. In this case, the heat delivered to the weld will be proportional to I^2t.

Thus, if the current is the same for a series of welds and the duration of current flow the same, the heat developed would be the same, except for proximity effect which must be considered when welds are placed near together. This causes some of the current to be shunted through the completed welds and reduces the heat delivered to the weld which is being made. We shall disregard this variable for the present and consider only the problem of making a single isolated weld where all the current must pass through the weld proper.

Before discussing the influence of each of the variables just mentioned, it becomes necessary first to define the characteristics of a good weld in stainless steel 18–8. We have established certain desirable characteristics and properties of a good weld and good welding conditions as follows:

1. The weld must be neat in appearance.
2. The weld must be of such a size that a certain minimum valuable strength is obtained.
3. The weld must not be so large as to require flanges of a size which will interfere with weight saving in the final structure.
4. The penetration of the fused metal into the outer layers of the piece being welded must be held within certain limits. The fused penetration must not extend to the surface of the metal being welded.
5. The conditions of welding must be such that neither the weld nor the metal surrounding the weld contains harmful carbide precipitation.
6. The conditions of welding must be such that when welding stainless steel cold rolled to high tensile strengths, the extent of the annealed zone surrounding the weld is held to a minimum.
7. The conditions of welding must be such that they can be easily reproducible in the shop.
8. The conditions of welding must be such that uniformity of welds in a given series of welds is definitely maintained.

Primary Variables

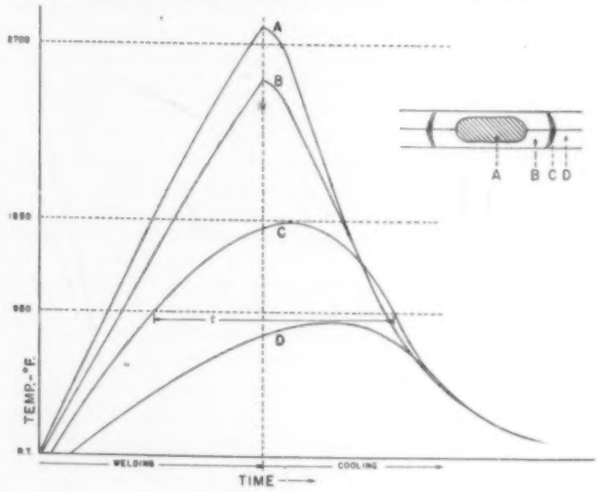
There are four principal variables which directly affect these characteristics and conditions:

1. The welding electrodes:
   (a) Material.
   (b) Shape.
   (c) Size.
2. The pressure on the welding electrodes.
3. The time of current flow.
4. The amount of current.

1. The Welding Electrodes.—The reasons for a proper choice of electrode material become clear when it is considered that the conditions existing in the metal during and immediately after the making of a weld are to a large extent dependent upon the size of the electrode, the shape of the electrode and the thermal and electrical conductivity of the metal in the electrode.

If these were the only considerations, however, the choice of a proper electrode material would be comparatively an easy one, but it so happens that the important property of wear resistance decreases rapidly as the other desirable properties increase, and vice versa. Likewise, a good electrode material may be condemned as unsatisfactory because other conditions such as the time of current flow, pressure, etc., used in making the weld are incorrect. In welding light gage steel this becomes of added importance when it is considered that during the making of a weld in two thicknesses of 0.008-in. thick metal, the molten metal (temperature some 2600° F.) is often only sixteen ten-thousandths of an inch away from the electrode. This is about one-half the thickness of the paper on which this is written. In spite of this the electrode must be left unharmed during and after the welding.

Fig. 3(*a*)—Effect of Long Welding Time and Low Rate of Cooling



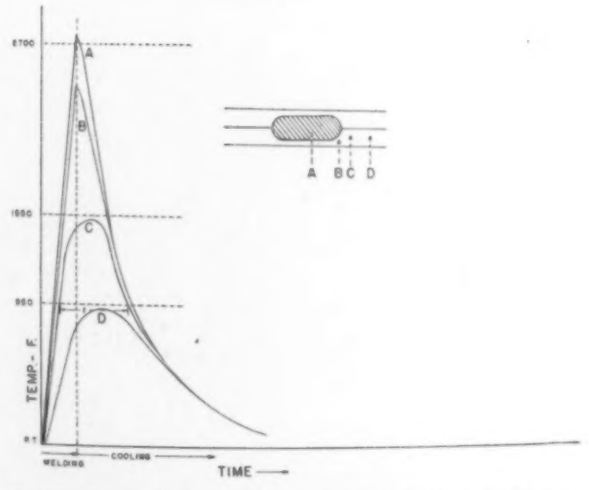


Fig. 3(*b*)—Effect of Short Welding Time and Rapid Rate of Cooling

(*a*) *Material:* Experience has shown that with the materials at present available for electrodes, it is necessary to effect a compromise between high electrical and thermal conductivity and the equally important property of resistance to wear.

Our investigations in the laboratory and particularly our experience in the shop have shown conclusively that for the welding of light gage steel an electrode material having a slightly lower resistance to wear and a higher electrical and thermal conductivity gives better results than a harder material with a lower electrical and thermal conductivity. As already mentioned this is because the proximity of the molten metal causes high temperatures to be reached on the surfaces of the metal under the electrode. When making single spots at a very low rate of production the effect of this is small, but at high rates of production in the shop the wear and consequent change in shape of the electrode increase markedly. We have found that the copper base alloys (essentially copper and small amounts of silicon, beryllium, etc.) give good results. In general, these alloys have a Rockwell hardness on the "B" scale of about 80 and an electrical conductivity of about 75% that of pure copper. For heavier gage welding, i.e., over some 0.025 in. in thickness a harder material is more suitable because of the higher electrode pressures used. For this we use a copper-tungsten alloy having a Rockwell hardness of about 95 on the "B" scale and having an electrical conductivity of about 35% that of copper. Disks of this alloy are silver-soldered to the tips of electrodes made of the softer higher electrical conductivity alloys.

(*b*) *Shape:* The shape of the tips of the electrode is of very great importance in resistance welding. We have found that a slightly rounded ($1^1/_2$-in. radius) tip gives the most consistent and uniform results. True it is that good isolated welds can be made with flat tips, but experience has shown that a slight concentration of the pressure (and hence a slightly increased current density) is desirable. A slightly rounded tip also makes for better welding conditions where portable tools are used in order to compensate for unpreventable misalignment of the work and the tool.

(*c*) *Size:* The size of the electrode, i.e., its diameter, is governed in part by the size of the weld desired, the width of the flange or lap, and the practical desirability of having the smallest possible number of sizes in the shop.

2. Pressure on the Welding Electrodes.—In general, the greater the pressure on the welding electrodes, the better and more sound is the resulting weld. This is because high electrode pressures make for more even pressure distribution and reduce the interface contact resistance and make necessary somewhat higher currents. However, the amount of current does not have to be as great in the case of stainless steel as in the case of some other metals. This is because of the high resistivity of stainless steel and consequently the interface contact resistance can play a smaller part in heat generation. This is not true for metals of low electrical resistivity. In addition, high electrode pressures reduce, also, the resistance at the contact of the electrode and the steel, and, therefore, prevent undesirable heating at this point. The heat at the contact of the electrode must be kept as low as possible in order to avoid softening of the electrode and to avoid melting the steel at this point. Thus, the high pressure on the electrodes

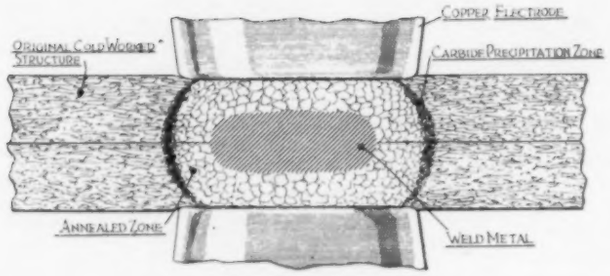


Fig. 4—Improperly Made Weld in 18–8

produces in stainless steel 18–8 a considerably greater reduction of the undesirable electrode contact heat without appreciably reducing the welding heat.

It sometimes happens that the interfaces are not perfectly flat but have an outward bulge which may require appreciable pressure to bring them into contact. Thus, the net pressure which determines the contact resistance may be quite different unless the total pressure is so large that this difference is a negligible per cent of the whole. This is particularly important in sheets of heavy gage, since their rigidity is proportional to the cube of their thickness. Hence, the higher the total pressure, the smaller will be the variations in net pressure.

3. The Time of Current Flow.—In the resistance welding of stainless steel by our process, the time of current flow is decreased until the temperature gradient between the molten metal in the weld and the surrounding material is so steep that the time of dwell of the weld or of any part of the metal within the carbide precipitation range is so short that no harmful carbide precipitation occurs. Figures 3 (*a*) and 3 (*b*) show curves illustrating the effect of time of current flow on carbide precipitation. On the temperature axis are noted room temperature, the carbide precipitation zone limits of 950° and 1550° F. and the approximate fusion temperature of stainless steel, 2700° F. The time axis shows the time of current flow and the rate of cooling. Figure 3 (*a*) shows the effect of a long welding time and low rate of cooling on the length of time for which Zone "C" is held in the carbide precipitation temperature range. This is indicated by *t*. Figure 3 (*b*) illustrates how time *t* can be greatly decreased by decreasing the welding time and increasing the rate of cooling. In our process, this time is so short that no harmful carbide precipitation occurs.

Figure 4 shows a drawing of a cross section of an improperly made resistance weld in stainless steel 18–8. It should be noted that there are four distinct zones in this weld.

(*a*) *The Weld Metal:* This is a "pressure casting" of the metal being welded. In stainless steel 18–8 the properties of this metal are practically the same as those of the annealed metal around the weld.

(*b*) *The Annealed Zone:* The occurrence of this zone is due to the juxtaposition of metal, i.e., the weld metal, itself, which was during the welding in a molten condition. The presence of this annealed zone is desirable in a weld in cold-rolled metal because of its high ductility. It is clear, however, that an annealed zone of too great a width would be undesirable because, if in welding the cold-rolled steel this annealed zone were to overlap that of a neighboring weld, the strength of the joint would be lowered. (It is, of course, clear that if the steel has not been cold rolled prior to welding, the width of the annealed zone would not be important.) Our process holds this zone to a minimum.

(*c*) *Carbide Precipitation Zone:* This zone, if it exists, is subject to corrosive attack and in severe cases the whole weld together with the annealed zone may drop out. Harmful carbide precipitation is not present in welds made by the above mentioned process.

(*d*) *Cold-Worked Structure:* It is, of course, clear that this structure would not be present if the steel were in the annealed condition prior to welding.

4. The Amount of Current.—The amount of current is partly governed by the size of the weld desired, but for the most part the proper amount of current is dependent upon its co-relationship with the other three variables.

The Interrelationship of the Four Primary Welding Variables

In order to obtain experimental data as to the interrelationship of the four primary variables just described, a series of welds were made for each thickness under known values for each of the different variables.

Such a series of welds is shown in Fig. 5 by the black dots on constant current curves. A constant time of current flow was used. The position of each dot on the abscissa was obtained by averaging five weld strength values as shown in a lap joint pulled in the tensile machine. A representative weld corresponding to each plot was sectioned, polished and etched and the percentage penetration of the fused metal into the outer layers of the metal being welded was measured under the microscope using a graduated eyepiece.

In addition to the plots just described, very careful records were kept as to what conditions existed when fused metal was forced, during welding, out between the sheets. In welding parlance a record was made as to when "spitting" commenced. While it sometimes is desirable to choose welding conditions on the "hot" side (high current), more than slight "spitting" is undesirable because of the loss of molten metal which, clearly, causes a decrease in weld size and makes for non-uniform welding.

Two curves were then drawn on the diagram, as shown, and marked "Too hot," i.e., "spitting," and "Too cold," i.e., when the penetration decreased below 50%. The reason for the choice of 50% fused penetration as a minimum allowable amount lies in the fact that experience has shown that if this value is not chosen for "optimum weld conditions," non-uniform welding results. This does not mean, we should like to emphasize, that a weld having less than 50% fused penetration is not as good as one having over this amount. It

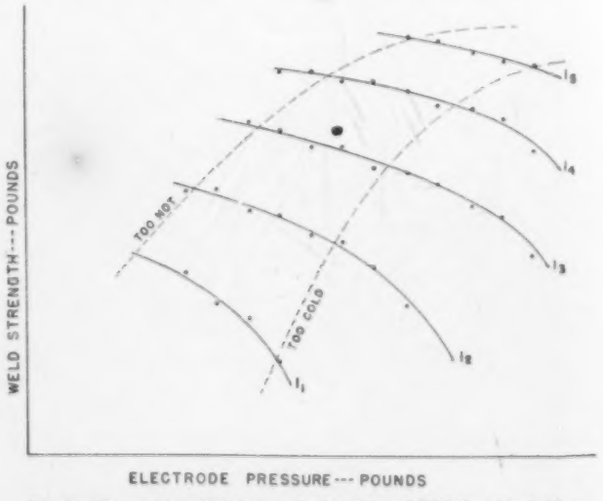


Fig. 5—Curve Showing Interrelationship of Welding Variables

means, simply, that if an optimum weld condition were chosen having less than 50% fused penetration uniform weld strength values are very difficult to obtain in the shop.

Examination of Fig. 5 will show that good uniform welding conditions can be obtained by using any of the combination of variables which fall between the "Too hot" and the "Too cold" curves. Examination will also show, however, that at high electrode pressures the optimum welding zone becomes narrower in width and that a given percentage drop in current values lowers the amount of fused penetration to an amount which might lead to non-uniform welding and a given percentage increase in current values tends toward producing a weld which is too hot.

For these reasons and because portable tools are not satisfactory for very high pressures, on account of their large size, the optimum weld condition has been chosen for the conditions shown by the large black dot.

In closing, it should be pointed out that the curves just described are typical of the methods used to obtain optimum welding conditions and vary somewhat for different thicknesses of steel and for different welding times. Our experience has shown, however, that optimum welding conditions can be obtained and maintained only by large-scale measurements such as these.

Acknowledgments

The authors should like to acknowledge the cooperation of Mr. Edw. G. Budd, Jr., Vice-President, and Mr. Joseph W. Meadowcroft, Assistant Works Manager, of the Edw. G. Budd Mfg. Co. We should also like to thank Dr. C. A. Adams, Consulting Engineer for his suggestions.

Welding Applications in Naval Machinery*

By Hugo W. Hiemke† and John D. Bert‡

THE machinery installed on Naval vessels has to be designed to meet a combination of service requirements which challenges the ingenuity of its builders. The primary concern is to build machinery which is reliable in its operation. The failure of even a minor part of the machinery plant during a Naval engagement might mean the difference between victory and defeat. Superimposed on this requirement of unquestioned reliability are weight and space limitations, the ability to resist explosive shock, and operation in an inclined position, all of which are peculiar to the needs of Naval shipbuilding. The economy factor is represented by a desire to have as large a cruising radius as possible, after all the other required conditions are satisfied.

* The statements made in this article are the opinions of the authors and are not the official views of the Navy Department. Presented at the Annual Meeting, A. W. S., Philadelphia, Pa., Oct. 20-24, 1941.

† Senior Materials Engineer, Bureau of Ships, Navy Department.

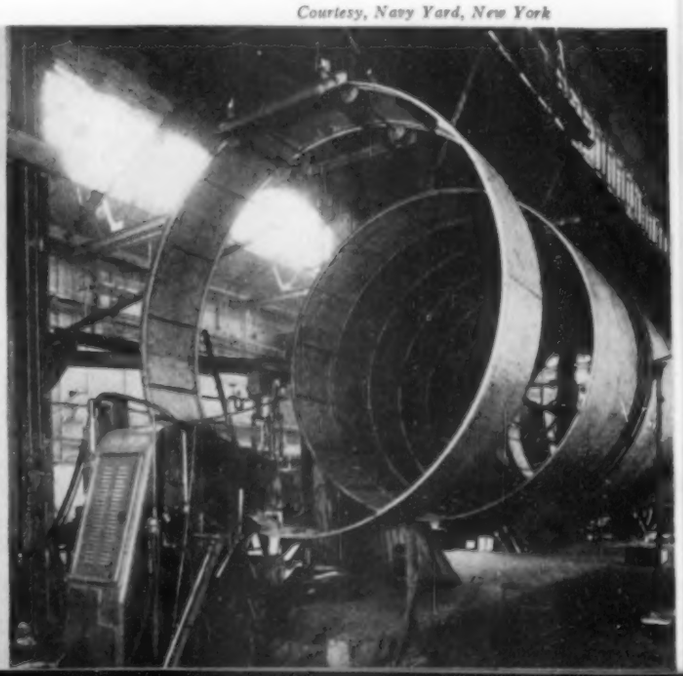
‡ Welding Engineer, Bureau of Ships, Navy Department.

Fig. 1—Welded Boiler Drum Showing Circumferential Seam and Nozzle Connections

Courtesy, Foster Wheeler Corp.

Fig. 2—Outer Casing of Smokestacks being Fabricated by Resistance Welding

Courtesy, Navy Yard, New York



It is no wonder that marine engineers were conservative in their application of welding to ships' machinery. First it was necessary to prove that welding could contribute something to the reliability of operation, or, otherwise, that it produced equal reliability compared to the fabrication methods it sought to replace, and at the same time made it possible to decrease the size and weight of the machinery.

Painstaking research preceded all of the applications of welding on shipboard. Until it could be demonstrated that welding was capable of producing reliable joints, having both the strength and the toughness of the metal being joined, shipboard applications of welding were unimportant. After the basic physical properties were known, additional testing was done to be certain that welding was entirely satisfactory for a particular application.

It may seem strange that the first important application of welding to Naval machinery was on the drums of steam boilers, perhaps the most hazardous service on board ship. Riveting, which has been the accepted method for fabricating boiler drums for a long time, has certain definite limitations. As the thickness of boiler plate increases, the difficulties of making, and maintaining, pressure tightness in a riveted seam increases greatly. Also, tightness of a riveted seam is achieved by producing a state of initial stress in the plates and the rivets, which, added to the operating stresses, tend to produce premature failure of the drum, by the formation of stress-corrosion cracks between rivet holes.

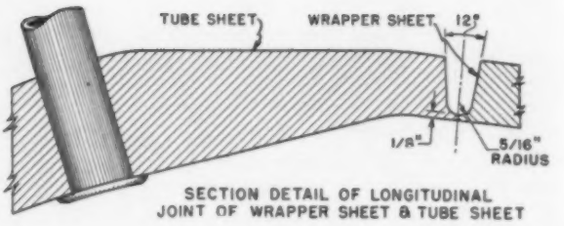
Welded boilers can be put into service substantially free of internal stresses. No stress-raisers, such as are caused by rivet holes, are present in welded joints. It is safe to expect, therefore, that welded drums have a measure of superiority in reliability of operation over riveted drums. Furthermore, the use of welded drums removes the ceiling on design pressures which riveting entails.

With these advantages to be gained, it seems, in retrospect, quite natural to accept welding for boilers. It must be remembered, however, that at the time of approving the use of welded boiler drums welding had not been approved for land boiler service, where the limitations of design are not nearly so exacting. It is a tribute to the courage and foresight of the Naval Officers who, in August 1930, approved the use of the first welded high-pressure steam boilers in this country. These first boilers have been in service for over eight years without giving any trouble whatsoever.

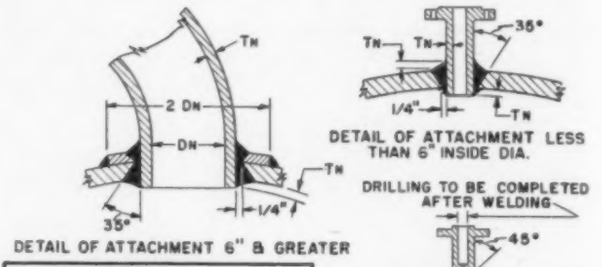
The following statement by Dr. D. S. Jacobus, which appeared in the October 1940 issue of THE WELDING JOURNAL, aptly describes the importance of this early approval of welding, "In August 1930 . . . the Bureau of Engineering of the Navy Department issued specifications for fusion welded drums . . . and a number of steam and water drums for boilers . . . were constructed for the U. S. Navy. This was the turning point in what proved to be a rapid advance in the development and use of fusion welding."

We have endeavored to show why welding was adopted for boilers, but we should also like to touch on the question of why boilers were not welded long before 1930. The development of covered electrodes made the difference between acceptance and rejection of the method. Until 1930, the application of electric arc welding was drastically limited because of the relatively low ductility obtainable with bare and lightly coated electrodes. It was only after the development of covered electrodes made it practicable to produce sound welds in heavy plate with both the strength and the ductility of the plate itself that responsible engineers were willing to accept welded boilers. This same criterion influenced the acceptance of welding for many other important engineering applications. After ductile weld metal was available, it remained only for the ingenuity of the design engineer to apply welding properly—to utilize welding in the solution of his problems—and its acceptance was practically assured. Some of the developments seemed slow in coming, but, in retrospect, the truly remarkable thing is the rapidity with which time-honored fabricating methods were either replaced or evolved to utilize welding. In less than 10 years, we have gone from the phrase "no welding will be permitted" to "consideration will be given to the use of welding," and now, "welded construction shall be used." Machinery units on which welding is not now used are few indeed.

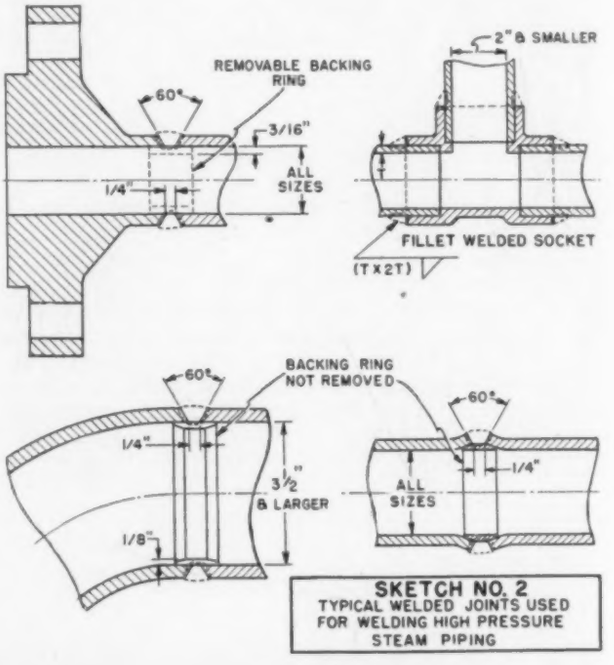
There are two requirements which are common to all welding, and will therefore be discussed before going into



SECTION DETAIL OF LONGITUDINAL JOINT OF WRAPPER SHEET & TUBE SHEET



SKETCH NO. 1
TYPICAL WELDED JOINTS FOR BOILER DRUM & ATTACHMENTS



SKETCH NO. 2
TYPICAL WELDED JOINTS USED FOR WELDING HIGH PRESSURE STEAM PIPING

Fig. 3—Welding High Pressure Piping Manifold Using Positioner

Courtesy Navy Yard, Philadelphia

Courtesy Navy Yard, Philadelphia

Fig. 4—Hardfacing of High Pressure Valve Seat Ring

the special requirements of the individual types of machinery.

Electrode Requirements

The electrodes used for welding Naval machinery are required to be of an approved type, that is, they must be brands of electrodes which have previously been tested by a Naval laboratory and found to be entirely suitable for Naval use. Just as the original acceptance of welding depended on the development of electrodes capable of producing quality weld metal, the control of welding is dependent on the maintenance of that quality. Without proper electrodes, all other control would be fruitless.

Qualification of Welders

Next in importance to the selection of the electrodes is the qualification of the welders. All welders are required to pass root and face bend tests, using the well-known guided bend test. Pipe welders must pass these tests using specimens cut from pipe similar in size, thickness and composition to the pipe they will be required to weld.

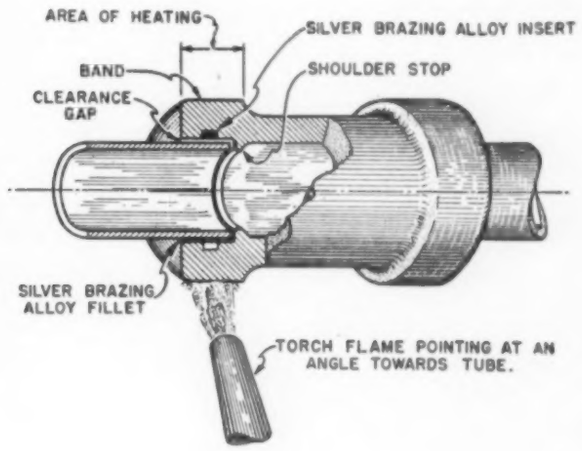
Each type of machinery involves special problems and we will try to present some of these problems, the means by which these problems were solved, and the special fabricating and inspection requirements which are currently used on various types of machinery to control the quality of the welding.

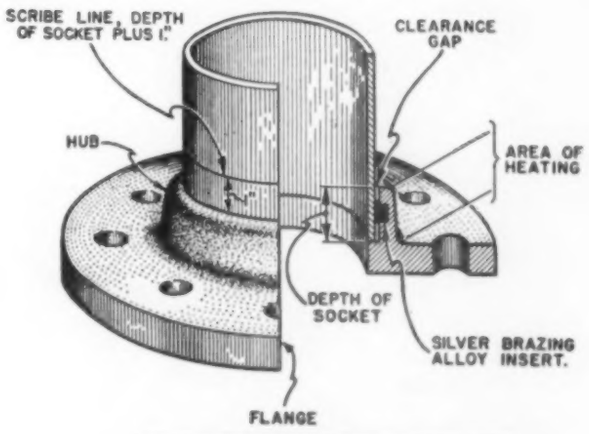
Welded Boilers

Because of the special hazards of their service, the welding of boiler drums is surrounded with numerous special controls or safeguards, namely:

1. Qualification of welding process.
2. Use of automatic welding.
3. Limitations of joint design.
4. Radiographic inspection.
5. Magnaflux inspection.
6. Fabrication tests.
7. Stress relieving.

Manufacturers who desire to fabricate welded boiler drums for the Navy, must prepare a process approval test plate using automatic welding equipment and the





SKETCH NO. 3

INSERTED RING TYPE FITTINGS USED FOR SILVER BRAZING PIPING

electrodes, joint design and other details which will subsequently be used in production which will meet the prescribed requirements. These tests are conducted at the Engineering Experiment Station, at Annapolis, Md.

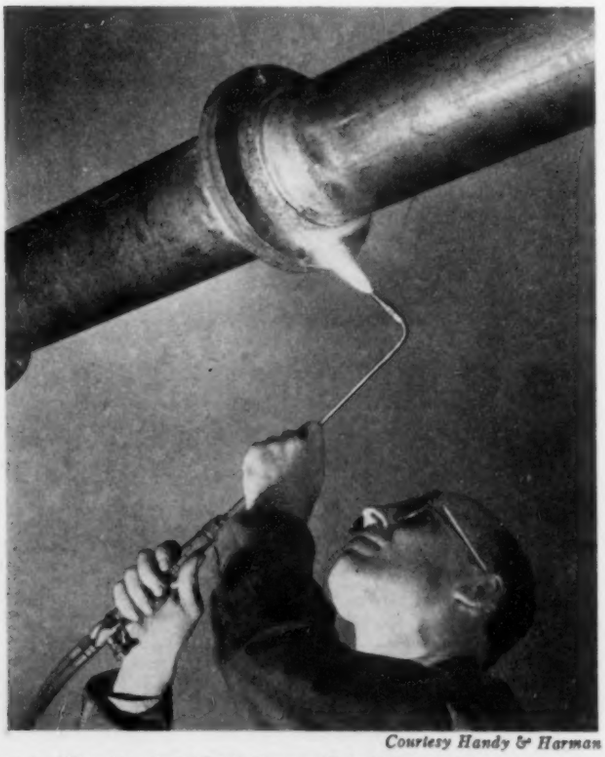
The welding of all longitudinal and circumferential seams of boiler drums is required to be done with the automatic metal arc process. Figure 1 shows a boiler drum which has been welded by means of automatic equipment. Manual welding is permitted for the welding of the inside of the longitudinal and circumferential seams of the drums and all welding of nozzles, pads and attachments.

The joint design most used for the circumferential and longitudinal seams and for nozzles are shown in Sketch No. 1. These seams are required to be radiographed in their entirety. The surfaces of all welds around nozzles, pads and other attachments to the openings are ground smooth and tested by means of the magnaflux method.

A fabrication test plate attached to one end of a longitudinal seam is welded with each boiler drum. Bend tests and an all-weld metal tension test are made to be sure that the actual weld in the boiler is as good as the process approval test.

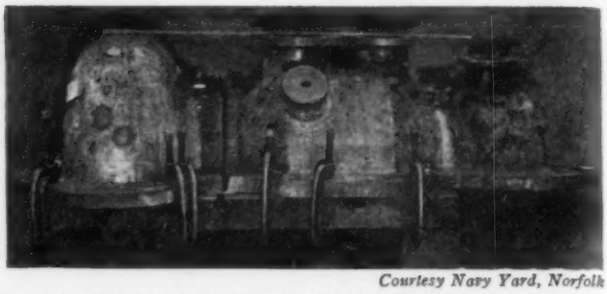
The welding of 4–6% chromium, 0.5% molybdenum headers is also controlled under the very strictest of rules. No welding is permitted until the base metal is softened by annealing. Before starting to weld, the headers are preheated to a temperature above 500° F. and after welding the entire header is stress relieved at 1200° F. for 4 hours and slowly cooled. Special chromium-molybdenum welding electrodes are used. All welds including nozzle joints are required to pass 100% radiographic inspection or magnaflux inspection.

Under the rigid controls exercised in their execution, the welds in boiler drums are probably as reliable as any form of metal product. Up to the present time, approximately 1845 boiler steam and water drums of welded construction have been fabricated for Naval vessels.



Courtesy Handy & Harman

Fig. 5—Silver Brazing 6 Inch Copper Nickel Flange Joint in the Horizontal Fixed Position



Courtesy Navy Yard, Norfolk

Fig. 6—High Pressure Turbine Casing of Cast-Welded Construction

These contain two longitudinal and two circumferential seams. In addition, an even larger number of superheater, economizer and water wall headers have also been fabricated by the use of welding.

Boiler Casings and Stacks

Boiler casings and outer stacks of Naval vessels are of spot-welded corrosion-resistant steel construction, because of the saving of weight obtainable by this method of fabrication. The casings are made up of sections bolted together, each section being stiffened by formed channels spot welded to the sheet. The corners of the panels are made gastight by means of atomic-hydrogen welding.

In the construction of stacks, the outer skin is stiffened either by a continuous corrugated inner panel or by intermittent Z-bars. In the Z-bar construction, the outer skin is usually of heavier gage sheet than is the case with the corrugated panel design.

Spot welding of these structures is required to be performed on automatically timed machinery and process approval tests are conducted on each manufacturer's process before proceeding with production welding. During production, fabrication tests are made when the machine settings are changed and also periodically during the working day to check the uniformity of the work.

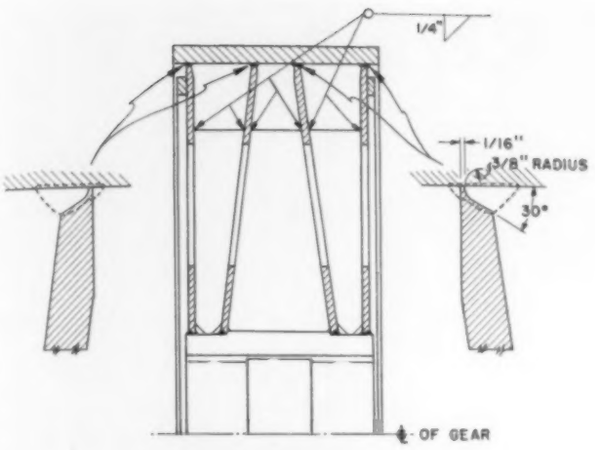
The details of construction of stacks for Naval vessels are being presented in an article by H. O. Klinke, welding engineer of the Philadelphia Navy Yard, in another paper of this session.

Figure 2 shows the operation of spot welding a stack for a cruiser. In this particular case, the stack sections, 54 inches in length, are stiffened by longitudinal Z-bars and circumferential channels.

High-Pressure Piping

The use of welding for high-pressure high-temperature steam lines for Naval ships has been a gradual evolution from the vanstoning and bending methods of fabrication. Both systems are being used in ship construction at the present time. In the future, it is likely that there will be a tendency for the elimination of all flanges but this change will be slow in coming due to the fact that there are many places where it is desired to have flanged connections so that sections of piping may be removed to provide space to service machinery. Most of the welded high-pressure steam lines are made of carbon molybdenum alloy steel and are welded in the shop using positioning equipment, as shown in Fig. 3. The welded joints most used are shown in Sketch No. 2. Welding operators are qualified for welding high-pressure piping by being required to make satisfactory welded pipe specimens in the horizontal fixed and vertical fixed positions.

When assembling piping and fittings that may require the use of a backing ring for welding it has been found



SKETCH NO. 4
WELDED LOW SPEED GEAR

necessary to expand tube ends to a predetermined inside diameter in order to line up the backing rings on the inside of the joint. The 15% tolerance permitted on the thickness of piping produces unequal inside diameters of the piping and fittings.

Each welded joint in the high-pressure piping system above $3^1/_2$ inches in size is required to be radiographed in its entirety. Sizes $2^1/_2$, 3 and $3^1/_2$ inches are required to be inspected by means of partial radiography representing at least 60° of the circumferential seam. When defects are located by means of this partial radiography the entire circumference of such welds is radiographed, the necessary repairs effected, and radiographs of the repairs made. All radiographs are compared with the Bureau's Radiographic Standards for Class A-1 Pressure Vessel Welds to determine the acceptability of the areas represented. Butt-welded flange joints in the size range $2^1/_2$–$3^1/_2$ inches, inclusive, may be inspected by using magnaflux on the inside of the pipe in way of the weld after the backing ring has been removed.

Disks and false seats for high-pressure steam valves are faced with hard-surfacing material. Figure 4 shows a valve seat ring having an overlay of chromium-cobalt-alloy applied to the inner edge, which forms the seat. The part being hard faced is preheated before welding and allowed to cool slowly usually by immersion in powdered lime or other heat-insulating material. The inspection of these welded overlays consists of a careful surface inspection after grinding. For steam valve service, it is essential that these seats and disks be free of all defects.

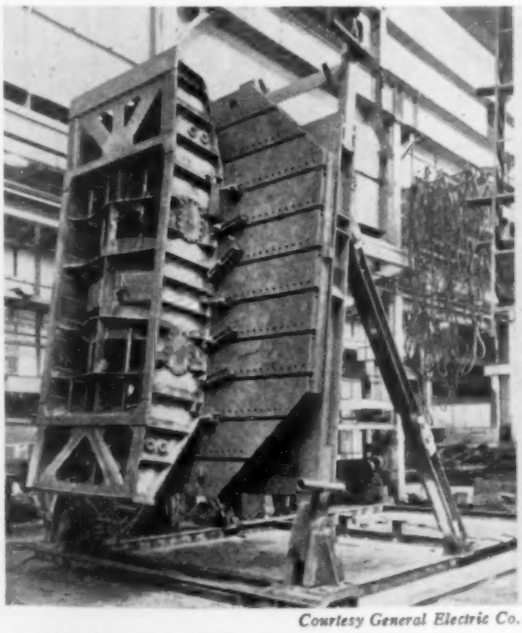
Low-Pressure Piping

In addition to the high-pressure steam piping a multitude of low-pressure systems are entirely welded. The ferrous piping systems are either oxyacetylene or arc welded, and the non-ferrous systems are, for the most part, silver brazed.

The joint most used for brazing piping is the inserted ring fitting shown by Sketch No. 3. This joint is used because it gives a visual indication of the completion of the joint, when a ring of silver brazing alloy forms at the mouth of the fitting.

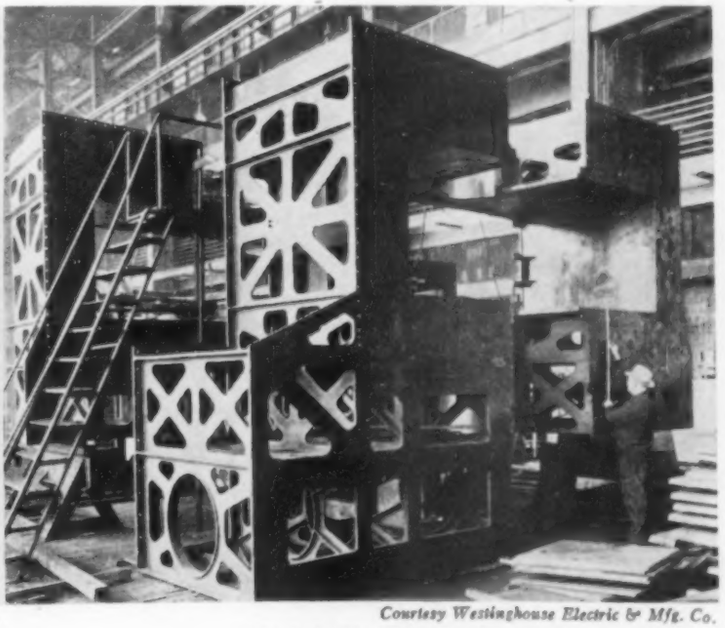
Like all welding operations, silver brazing requires careful procedure control for its successful application. Operators must be qualified before proceeding with production brazing. Close tolerances between tubing and fitting are essential in order that the capillary forces may operate. This requires special tolerances on the O.D. of the tube and close tolerances on the I.D. of the fitting. The tube has to be trued up to a perfect circular shape before inserting it into the fitting. Proper cleaning and proper fluxing are essential.

Silver brazing is particularly advantageous for making joints in copper pipe lines, although it is also used on 70–30 copper-nickel alloy, monel pipes and some steel pipes, such as lubricating oil pipes, which operate at relatively low temperatures. Appreciable weight savings have been effected by the replacement of threaded joints by silver brazed joints in pipe lines, and leak-proof joints are readily obtained. Figure 5 shows a 6-inch



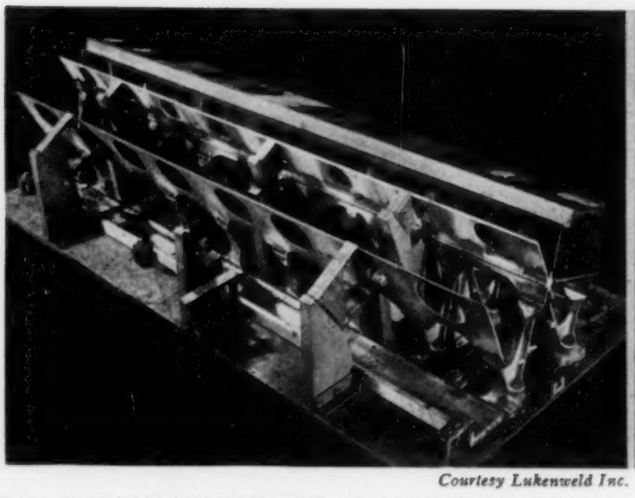
Courtesy General Electric Co.

Fig. 7—Low Pressure Turbine Casing Being Welded on Large Positioner



Courtesy Westinghouse Electric & Mfg. Co.

Fig. 8—Welded Gear Case



Courtesy Lukenweld Inc.

Fig. 9—Partially Fabricated Diesel Engine Frame Showing Method of Assembly

Courtesy Lukenweld Inc.

Fig. 10—Diesel Engine Frame Being Welded on a Large Welding Positioner

copper-nickel flanged joint being brazed in the horizontal fixed position.

High-Pressure Turbine Casings

Steel castings have been used for high-pressure turbine casings during the last 20 years. Before that high-pressure turbine casings were made of cast iron. Cast iron is an ideal material for casting the complex shapes which are almost invariably present in turbine casings, but because of its low shock resistance, the Navy Department decided, some 20 years ago, that cast-iron turbine casings were far too vulnerable for modern vessels of war. The correctness of this decision has been amply verified by experiences in the present European war.

By changing to cast steel, an inherently ductile material was obtained, but the steel foundry industry was presented with a baffling problem which was not completely solved until dependable welding was available to help with the problem. Cast-steel turbine casings had a habit of springing a leak at inopportune times, necessitating emergency repairs. Welding got its start as a repair method for fixing these leaks. When it had proved itself as an aid to reliable operation, welding gradually evolved as a primary fabrication method for turbine casings. Because of the complex shapes involved, an all-welded structure using plates and shapes is out of the question for economic reasons. The best solution has been reached by making simple castings (which are relatively easy to cast sound) welded together to make the completed casing. Certain basic principles of cast-welded construction have been evolved.

1. All flanges which would have to be cast in the drag of the mold are cast separately and welded on.
2. Ribs and lugs are cut from wrought material and welded on.
3. Small bosses are deposited by means of welding.

Welding of turbine casings is controlled by the following special welding requirements:

1. Qualification of welding process.
2. Limitations of joint design.
3. Radiographic inspection.
4. Stress relieving.

The process qualification tests for welding of high-pressure turbine casings are conducted on cast carbon-molybdenum steel plates, using carbon-molybdenum electrodes, to determine that each manufacturer can produce satisfactory C-Mo welds before proceeding with the actual fabrication. Figure 6 shows a partially completed turbine casing of cast-welded construction. Note the groove preparation of the joint set up for welding. In this design the pressure walls are all of cast steel, and the external stiffeners are steel boiler plate. All the flanges were cast separately and welded on.

Another important application of cast-welded construction has been made in the fabrication of a throttle valve manifold which was originally a one-piece casting. This casting was extremely difficult to cast sound. By casting the pressure part of the assembly in five pieces, using wrought plate for the structural members, and welding them together, a very satisfactory manifold was obtained. Incidentally, the redesign resulted in certain simplification of form without affecting the functional characteristics of the part.

Low-Pressure Turbine Casings

Low-pressure turbine casings are also, in a sense, of cast-welded construction, since the conical section in which the blade grooves are cut, and the bearing supports, are cast steel. All the rest of the structure is composed of welded plate. The assembly of a relatively large number of component pieces to form a machine of closely prescribed dimensions presents a problem in erection which involves the planning of welding sequence and the preparation of fixtures and strongbacks to control distortion. The necessity for controlling fixed dimensions in welded machinery parts influences the welding procedure, in that locked-up conditions are inevitable. Cracking can be avoided primarily by the selection of ductile base metal and electrodes, and internal stresses are relieved after welding by furnace stress relieving.

Economy in welding, as well as improvement in weld quality, is achieved by welding in the flat position. Accordingly, shops which fabricate welded machinery parts employ welding positioners which can rotate the work so that flat position welding is possible. Figure 7 shows a low-pressure turbine casing being welded on a large positioner.

Gears and Gear Cases

Sketch No. 4 shows the cross section and a detail of the joint design of a welded low-speed gear of a main reduc-

tion gear. The rims are of forged steel requiring a Brinell hardness of 160 to 190. Because of the hardness required the steel used is permitted to have a carbon content of 0.40% max. and a manganese content of 0.90% max. Because of the inherent hardenability of the steel in the rim, magnaflux is used before and after stress relieving on all welds made to the rim. Other welds are not required to be magnaflux inspected because the steel of the remaining members is ordinary medium steel.

Figure 8 is a welded gear case made of medium steel. This type of construction with its comparatively light plates has eliminated the difficulty that was experienced when the cases were of cast construction. At the present time the only castings used are the bearing supports. The procedure of assembling and welding must be carefully worked out in order to maintain accuracy of designed dimensions.

Diesel Engines

Before the advent of covered electrode welding, the frames of Diesel engines were made of cast iron. The main gas loads were carried through heavy bolts. The combination of cast-iron frames and bolts resulted in a very heavy construction. Diesel engines of this design weighed over 50 pounds per horsepower. By the use of a welded steel frame, the bolts were eliminated and a substantial weight saving was accomplished. While increased engine speed entered into the total saving in pounds per horsepower, welded frames were a big factor in producing modern Diesel engines, having a weight per horsepower of less than 20 pounds.

In addition to the main gas loads, Diesel engine frames are subjected to vibratory stresses of considerable magnitude. It is desirable, therefore, that the main welded joints be grooved welds, finished on both sides, and that great care be exercised to avoid undercutting, or rough welded surfaces. Figure 9 shows the method of assembly of a submarine Diesel frame, of 16-cylinder V-type construction. The assembly is of longitudinal plate and forged members, centering around a so-called wishbone forging, to which the other members are attached. Figure 10 shows one of these frames being welded on a large welding positioner.

Most of the welding on Diesel engine frames is done with the manual metal arc process using covered electrodes. Recently, certain manufacturers have found it advantageous to use the Unionmelt welding process for welding heavy members having seams of considerable length. Users of this process are required to prepare process approval test samples $1^1/_2$ inches in thickness before proceeding with production in order to determine the physical properties of the Unionmelt weld. For each type of joint, and type and thickness of material, the electrode size and composition, grade and mesh of melt, voltage, current and groove design are required to be determined. Also a transverse macro-etch specimen of the joint shall show complete penetration.

Heat-Transfer Equipment

Heat-transfer equipment of various kinds has been made of welded construction for a number of years. Welded fabrication has replaced both riveted and cast structures to insure freedom from leaks and to save weight. A few samples of the type of heat-transfer equipment involving special materials are shown in Figs. 11 and 12. Figure 11 shows a group of nickel-copper alloy deaerating feed-water heaters of all-welded construction. Figure 12 illustrates a welded condenser water chest of nickel-copper alloy construction. Metal arc welding, using covered electrodes, was used in both of these cases. The use of arc welding for fabricating this equipment depended on the development of electrodes which developed the strength, ductility and corrosion resistance of the base metal.

The forming of the monel sheets to the complex shape of a condenser water chest was accomplished by the use of a cast-iron form. The pieces of monel metal were formed to the desired contour and then welded, using double-welded butt joints. The shape of the plates and location of the welds were selected in a manner which would involve the least forming.

Electrical Machinery

Welding has also been extensively applied to the structures of electrical machinery. A special application of welding which deserves special mention is the flash welding of small generator frames. These frames are made by rolling a plate of steel to a cylindrical shape and then flash welding the longitudinal seam. The operation is extremely rapid and the quality of the work is quite uniform because of the mechanical control of the welding cycle.

Maintenance of Machinery

The use of welding for maintenance of machinery by Forces Afloat has been given careful consideration. Welding equipment is available on all combatant vessels. Enlisted men are qualified for welding and distributed throughout the Fleet.

A large variety of maintenance work, such as repairing of steel castings, resurfacing valve seats and disks, and building up of pitted and corroded surfaces, is done aboard ship and also by Navy Yard welders.

One of the important Navy Yard welding repairs is

Fig. 11—Nickel-Copper Alloy Deaerating Feed Water Heaters of Welded Construction

Courtesy Elliott Company

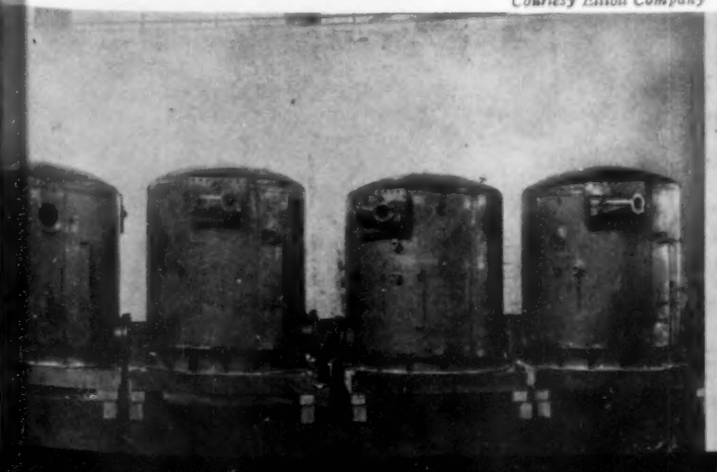


Fig. 12—Welded Nickel-Copper Alloy Condenser Water Chest

Courtesy Youngstown Welding & Engineering Co.

that of reconditioning manganese bronze propellers. Broken tips and sections of blades are repaired by using the oxyacetylene process. Pitted areas or minor repairs are built up by the use of metal arc welding.

Stress Relieving

A discussion concerning the welding of machinery, pressure vessels and piping would hardly be complete without a word concerning stress relieving. The operation of stress relieving is designed primarily to relieve internal stresses caused by differential shrinkage between weld metal and base metal, but the heat treatment temperature normally employed also produces a metallurgical effect. Stress-relief heat treatments are identical with tempering or drawing treatments; accordingly they produce a softening and toughening effect on the weld metal and the thermally affected zone of the base metal.

Machinery parts which are required to be machined to close tolerances should be stress relieved to produce dimensional stability. Welded parts, such as boiler drums, which are subject to aqueous corrosion as well as stress should be stress relieved to keep stress-corrosion effects to a minimum. It has also been considered desirable to stress relieve other important welded work, such as high-pressure steam piping in order that the piping systems may be placed in service in their best metallurgical condition, as well as being free of internal stresses.

Welded low-pressure piping, and low-pressure vessels and tanks are put into service without stress relieving. While the majority of important welded work in the machinery plant of a Naval vessel is required to be stress relieved, the amount of un-stress-relieved welds in low-pressure piping and pressure vessels is considerable.

Summary

The advent of covered electrodes has revolutionized the fabrication of Naval machinery. It has practically replaced riveting where that process was formerly used. Assemblies of simple steel castings, welded together, have replaced complex steel and gray iron castings. Many flanged and threaded joints in pipe lines have been replaced by welds.

In another field, silver brazing has emerged as the predominant method of joining non-ferrous pipes. Hard surfaced disks and seats of steam valves have greatly simplified the maintenance of valves.

In the field of sheet metal fabrication, spot welding and seam welding have received wide acceptance.

Welding can no longer be referred to as "the coming thing." It has arrived.

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Continued on page 169

Fig. 1—Twin Tube Steel Shell of River Crossing Section in Dry Dock. Temporary Opening in Bulkhead at End of Section. Part of Wood Forms in Place for Placing Exterior Concrete Lining

Fig. 2—Primary Lining for Single Tube Section on Curve

The Application of Welding in the Construction of the Chicago Subway*

By G. S. Salter, C.E.†

WELDING and burning played an important part in the construction of the Chicago Subways. In fact, their parts were so important, and so varied, that it is certain the progress achieved to date could not have been attained without their use.

In this discussion on the application of welding in the construction of the subways, it will be assumed that the reader is somewhat interested in other phases and details of construction and thus some descriptive matter pertaining to the various work on which welding was used will be included.

There was hardly a step in the construction of Chicago's first subways that did not have welding or burning connected with it in some manner or other.

The contractors used welding extensively in their plant equipment. This included the assembling of their shaft hoists, making joints and bends in air lines, installation of bulkheads and air locks, framing at bottom of shaft for mining drift tunnels, and all kinds of repair work on their mining equipment. Repairs to their pumpcrete lines, especially patching and reinforcing at bends where wear is rapid, were all done by welding.

Welding was especially efficient in framing around the opening from shaft to drift tunnel. The ribs and liner plates making up the shaft wall were easily welded to the channel or I-beam frame around the opening and then the members within the frame burned out to the exact dimensions of the drift.

Practically all tunnel construction was done under air pressures of from 8 to 15 lb. above atmospheric pressure. There is an inherent danger in the use of welding or burning under compressed air and definite precautions had to be taken to prevent accidents, both to men and material, under these conditions. Contractors had to make specific requests for the use of either acetylene torches or arc welders and tests had to be made to determine the presence of inflammable gases before beginning burning or welding. Tests were also made to determine the presence of carbon monoxide.

Stringent regulations were adopted for protection against fire. A minimum amount of inflammable material was allowed in the tunnel and this had to be kept at a safe distance from burning operations. An acceptable type of fire extinguisher had to be kept close at hand during all burning operations and as an added precaution the contractor was required to furnish a direct fire line from the top of the shaft to each heading. These lines, which were furnished with a City of Chicago fire department connection at the shaft end and a standard fire hose at each heading, were to be used only in case of fire.

Chicago River Crossing

Probably the most spectacular unit of the subway was the river crossing section in State Street. This is a steel twin tube structure 200 ft. in length, lined inside and out with concrete. The inner concrete lining has the same inside dimensions as the regular twin tube tunnel section and the steel tube is approximately the same shape except that the invert plate was made curved the better to withstand the water pressure.

The steel plate for the shells of these tubes was $^{5}/_{16}$ in. thick and butt welded throughout. One-eighth by $1^{1}/_{2}$-in. back-up strips were used at all joints. Twenty-five

* Presented at the December 19, 1941 Meeting, Chicago Section, A. W. S.

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rings, each 8 ft. long, were used to make up the 200-ft. length in each tube of the river crossing section. Each ring was composed of five plates varying in width from about 8 to 17 ft. More than 5000 ft. of weld was required in the longitudinal and transverse joints.

Welded to the outside of the shells at 12-ft. intervals were $^1/_4$-in. diaphragms that had the triple purpose of stiffening the shells, connecting the two tubes into one structure and making a series of pockets on the outside of and between the shells for placing the exterior lining. Approximately 6000 ft. of welding was required in placing these diaphragms and their connecting angles.

T irons were welded to the inside of the shells at the third points between the diaphragms. These T's, in combination with the diaphragms, provided stiffeners to the shell at 4-ft. intervals. They also provided a definite tie between the shell and the concrete lining. Over 8000 ft. of welding was required for attaching the T's.

About 20,000 linear ft. of welding was required in the complete assembling of the 200-ft. section with its appurtenant connections. The erection and welding of the tubes required 39 working days and slightly more than 6000 lb. of welding rod. The steel structure had a total weight of about 260 tons. On completion of the welding and installation of the steel bulkheads the interior of the shells was subjected to a low air pressure and a soapy water applied at all joints. Very few leaky joints were discovered and such joints were rewelded. After the twin tubes were towed to their final position at State Street, an examination made just before sinking the tubes showed that the leakage occurring during the 18-mile trip was negligible.

Since the twin tubes were assembled in dry dock in South Chicago and had to be floated and towed to their final position at the State Street site it was necessary to provide steel bulkheads at both ends of the tubes. The bulkheads were $^5/_{16}$-in. plate backed up with heavy I-beams, all assembled by welding.

All of the interior concrete lining could not be placed prior to the floating of the tubes as the section would not have passed over the sill of the lock. It was, therefore, necessary to place part of the lining after the section was floating in the river. An ingenious method of providing openings for placing this concrete was used. Three series of six openings at 12-ft. centers were cut out of the crown of the sections, each opening slightly smaller than the preceding one in the series so that after the interior concrete lining was placed the plate removed from one opening could be welded back over the next smaller opening. In this manner, only one new plate was required for each set of six openings.

The construction of the center, or island, type of loading platforms, which was used for most of the subway stations, required the use of a double row of steel columns supporting the triple arch section. These columns were at about 15-ft. centers and carried loads up to 700,000 lb. A heavy steel cap plate welded to the top of each column supports a double I-beam assembly. The I-beam assembly, which was also made up by welding, has a continuous steel plate on the lower flanges of the I-beams and a series of narrow tie plates on top.

Primary Lining

Welding was used almost exclusively in making up the temporary lining for all methods of mining. In the "open face" or "bench" method of mining the temporary lining consisted of various types of ribs and liner plates. In all cases the ribs were provided with foot or connection plates that were welded to the ends of the ribs. Most of the liner plates were of some type of pressed steel plate but many had welded corners.

For the shield method of mining the primary lining consisted of circular rings of heavy structural units that were capable of safely supporting the soil pressure until the concrete lining could be placed. Each of the rings was made up of 6 units. A typical unit was about 13 ft. in length, 2 ft. 9 in. in width and weighed about 1700 lb. The outside skin plate was $^3/_8$ in. thick with two side web plates of the same thickness and 10 in. in depth. The two inside flanges were 1 in. thick and $4^3/_4$ in. wide. There were also 11 transverse stiffening T's extending from web to web. These T's take the thrust from the jacks that move the shield forward. These primary lining units were made up completely by welding, about 65 ft. of weld being required for each piece.

Almost 39,000 units of this type of liner plates were required on the two contracts using the shield method of construction. A total of about 450 miles of weld, requiring more than 750 tons of welding wire, was put down in assembling these units. A saving of almost 25 per cent in the number of liner plates required was effected by the reuse of the plates that were removed in mining the station sections. Two units out of the six making up each ring had to be removed to permit con-

Fig. 3—Use of "Offset Assemblies" in Open Cut Construction on South State Street. Wales and Struts Were Welded for Flexibility in Variable Width Section

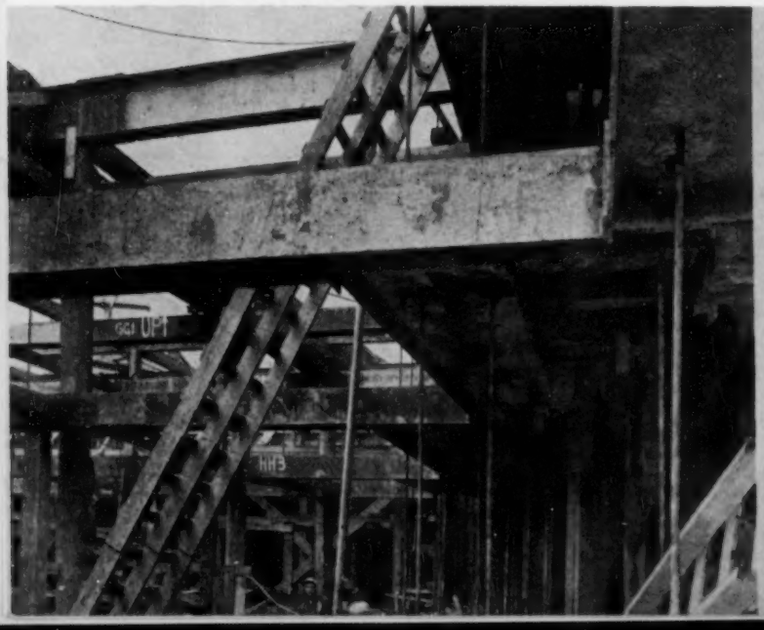
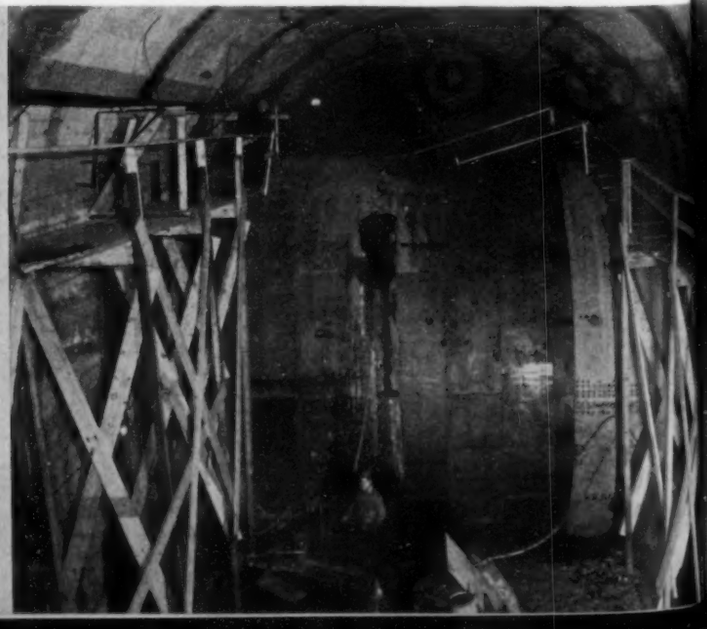


Fig. 4—Shield and Primary Lining in La Salle Street Street Car Tunnel. Shield Being Pushed Through East Wall of Tunnel. The Primary Lining Units Were Welded Together to Make Airtight Working Chamber



struction of the center arch and these plates were used on later mining operations. Considerable areas of the skin plate had to be burned out in order to remove the bolts connecting these two units to the ring of which they formed a part and these units were repaired by welding before reuse.

Welding was used extensively in making changes on the shield itself, such as special framing around the openings in the face of the shield and connections for mining equipment.

The two shields used for the construction of the subway in State Street were pushed from 11th Street to just north of Lake Street where the interiors of the shields were removed by burning, leaving the $2^1/_2$-in. skin plate which served as temporary lining until the section was concreted. About 100 man-hours of burning were required on each shield to remove the heavy interior framing.

Sheeting and Bracing

Portions of the incline connections between the subway and the elevated lines were built in open cut with the consequent use of heavy sheeting and bracing. H piles, WF beams and struts were usually used for this construction and in many cases were made up by welding. Welding was of particular value in making up the struts, as often their length could not be determined exactly until just before placing and then by welding or burning they could be made to the exact length required. The H piles for the open cut construction under the Roosevelt Road Viaduct on State Street and under the elevated structure on Lake Street had to be driven in short lengths. Welding was used to make up the total required length by connecting three or four short sections of piles.

The variable width open cut section on South State Street included the junction for a connection between the State Street and Wells Street Subways. This junction required the use of some special offset assemblies that the contractor found could best be made up by welding. These assemblies permitted the reuse of wales and struts used on the constant width section.

The sheeting in open cut construction was usually used as backforms for concreting the tubes. In most instances holes were burned through the steel sheet piling or the flanges of the H piles in order to insert metal tie rods for supporting the inside wall forms. This method of tieing eliminated costly interior bracing.

A picket fence of steel pickets supported by channel stringers and WF posts surmounts the concrete side walls of the portal sections. This fence is of all-welded construction with the pickets welded into holes cut in the webs of the channels and the channels welded to the posts.

Air Locks

At several points along the routes of the subways, crossover sections were constructed so that in case of emergency the subway trains can pass from one tube to the other. One of these crossovers is located on State Street a short distance north of the river, and, being constructed in open cut, was used as an entrance for mining a short section of twin tube tunnel section that was part of the same contract. Air pressure had to be used on all tunnel construction and thus the contractor decided to install his air lock in the crossover section. To provide better working conditions and to permit mining on both tubes leading away from the crossover section, the contractor elected to construct a bulkhead over the full area of the crossover section and install his air

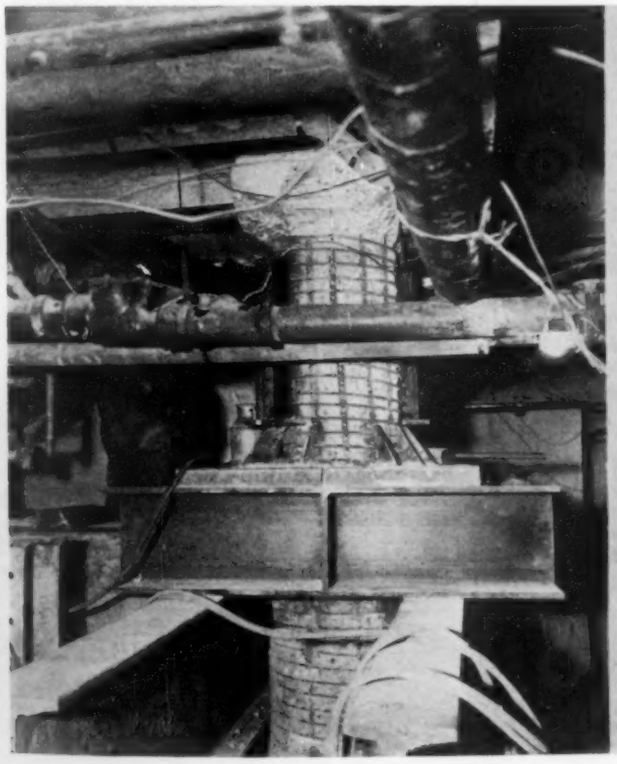


Fig. 5—Method of Shoring Reinforced Concrete Columns. Shows Assembly of T's, Plates and Fins Used to Transfer Column Load to Shoring Beams

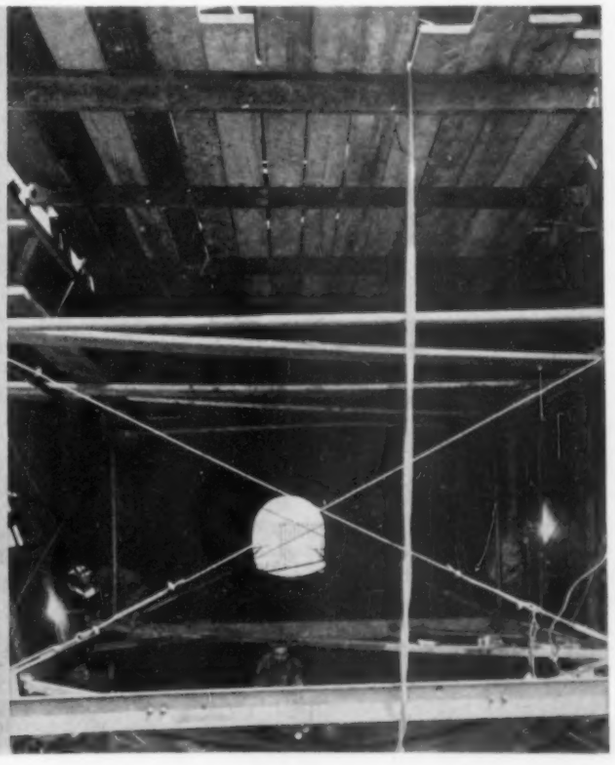


Fig. 6—Erection of Steel Shell for River Crossing

lock in this bulkhead. The bulkhead was constructed of 5/16-in. steel plate backed up with 16-in. WF beams and was of all-welded construction. The bulkhead was 17 ft. high and 34 ft. wide and proved very satisfactory with air pressures up to 15 lb. per sq. in. above atmospheric pressure.

A somewhat similar condition occurred at the old LaSalle Street tunnel where the two shields for construction of the Dearborn Street subway were assembled. The primary lining was assembled within the tail of each shield and pushed into a recess cut in the west wall of the tunnel where it was sealed with concrete. After the shields passed through the east wall of the street car tunnel another concrete ring was used to seal the lining at this point and then all joints between the plates making up the cylinder between the walls of the tunnel were closed by welding. Sections of the sides were burned out and cylindrical shells connected thereto by welding for installation of both man and material locks. All connections for air, water, hydraulic line to shield, and electric lines were also welded into these steel shells.

Steel forms were used for practically all tunnel construction and also for some sections in open cut. The arch forms, of welded construction, were the collapsible type and were made up in 5-ft. units that were usually assembled in lengths of from 25 to 60 ft. These forms were carried on one or two gantries operating on tracks laid on the completed invert. The invert forms were also of welded construction and in the case of the shield mined tunnels these forms were carried on a track that was supported on brackets fastened to the inner flanges of the primary lining. The brackets were fastened through holes burned in the flanges.

Fig. 7—Erecting and Welding Steel Twin Tube for River Crossing

Mezzanine Stations

There were many applications of welding and burning in the construction of the mezzanine stations, especially those within the Loop area. These stations were constructed in open cut and had to be decked over in order to maintain street car and vehicular traffic. Most of the contractors used H piles around the perimeter of the open cut with wood lagging to support the earth. These H piles were also used to support the outer ends of the decking beams and usually had either caps welded to them to support the beams or there was a direct welded connection between the beams and the piles.

Usually four to six interior piles were also required to support this decking. These piles were driven down to the steel liner plates of the completed tunnel but it was difficult to hold them in place on these curved surfaces until the bottoms of the piles were welded to these plates.

Steel ribs and liner plates were used in mining the center arch of the station sections. Parts of these ribs had to be removed in order to build the mezzanine stations and the remainder was supported in place by welding a short strut that rested on the concrete already placed.

Auxiliary structures for various purposes such as vent shafts, pumping stations and emergency exits are located along the line of the subway. These structures were constructed in open cut, usually sometime after the tunnel section was completed. In the bench method of mining, dowels and keyways were left at the outer face to provide for connecting the walls of these structures to the tunnel but with the shield method of construction these dowels and keyways could not be placed, so 5 x 3-in. angles were welded to the steel liner plates. By welding the angles to the skin plate a watertight joint was obtained, and reinforcing bars hooking into holes punched in the outstanding legs provided a very efficient anchorage between the tunnel section and the auxiliary structure. It was sometimes necessary to extend or replace dowels that were short or misplaced during tunnel construction. Dowels too short to provide proper anchorage were extended by welding bars to them, and missing bars were replaced by welding the reinforcing steel for the auxiliary structures to the exposed liner ribs.

Shoring of Buildings

Where subway construction passed under private property, it was necessary to support all structures that were to be maintained. This required some interesting and rather difficult shoring. One of the buildings that had to be shored was the 12-story Wilmar Hotel on Division Street. Some of the reinforced concrete columns of this building carry loads up to 550,000 lb. The columns could not be "picked" by "needling" or ordinary shoring methods without destroying the column, so the following procedure was devised. The concrete outside the vertical reinforcement bars was cut away carefully so as not to damage the spirals. Structural T's about 2 ft. 0 in. long, notched to clear the spirals, were then welded to the exposed verticals and a horizontal plate about 5 in. square was welded to the lower end of each T. These plates were used for the purpose of distributing the load into the concrete to be placed outside of the T's. Immediately below these plates triangular pieces, or fins, of 1/2-in. steel plate were also welded to the vertical column bars with the horizontal leg of these fins resting on and welded to a 2 1/2-in. thick horizontal steel plate fitted around the column. Outside of the T's and resting on the horizontal plate a heavy cylindrical steel shell was erected and the space between it and the column filled with quick-setting mortar. The column was then picked up by ordinary shoring beams located under the heavy steel collar and base plate. Both the 2 1/2-in. horizontal plate and the steel shell were made up of two pieces and connected by welding.

Some of the columns of this building were of steel con-

struction. Inasmuch as it was desirable to stay within the building lines with the shoring operations, connections were made to such exterior columns by welding the ends of shoring beams to the webs of the columns and "picking" them.

In most of the tunnel construction work no particular precautions were taken at construction joints to insure water-tightness as the temperature will be nearly constant with very little expansion or contraction, but in the station sections and in that part of the tunnel under and immediately adjacent to the river, steel plate seals were used in most of the construction joints. Bolted joints were indicated on the plans but the contractor found that field welding was more flexible and its use was permitted and used in most instances. Our later contracts have indicated the alternate use of bolting or welding.

Mechanical Equipment

Welding has been used and will continue to be used on much of the miscellaneous mechanical equipment for the subway. Grating and grating frames for all air-vent structures, stair railings for emergency exists and pumping stations and emergency exit covers are among the installations for which welding has been used almost exclusively.

Future Construction

The applications of welding discussed thus far have covered work that has been done up to the present time. It is expected that there will be many other applications of welding in connecting the subways to the present elevated structures, equipping them and placing them in operation.

Contracts have already been left for furnishing the structural steel for the incline structures connecting the subways to the elevated lines at both ends of the State Street route and at the north end of the Dearborn Street route. Plans are now out for bids on the erection of this steel at the north end of the State Street route. In this contract the elevated structure has to be widened by the addition of two exterior columns and cross girders connecting to parts of the present structure. The existing track stringer connections are too close to the ends of the present cross girders to permit riveted connections for the cross girder extensions, so welding will be used for making these connections.

Another application of welding will be in the remodeling of existing columns and column anchorages. Many columns will have to be strengthened on account of greater loads and this will be done by welding plates onto the outstanding legs of the existing Z's. It is expected that many of the existing anchor bolts will be found to be so badly deteriorated that they will have to be cut out and replaced. This will be done by burning off the deteriorated section of the bolt and welding an extension on the part left in place.

About the last step in putting the Initial System of Subways in operation will be the installation of track, power lines and a signal system. Welding will be used on all of this work. The rails will be welded into continuous units except for the breaks required for train control, signaling and other purposes. Some of these units will probably approach 800 ft. in length. Reduction in the number of rail joints will eliminate much rail noise. Power and signal lines will be bonded to the rails by welding.

The Chicago Subway System was designed by, and is being constructed under the supervision of, the Department of Subways and Superhighways, City of Chicago, Philip Harrington, Commissioner. Ralph H. Burke was chief engineer from December 1938 to March 1941. Since that time Charles E. DeLeuw has been acting chief engineer and Peter F. Girard assistant chief engineer. The project was financed jointly by the City of Chicago and the Public Works Administration of the Federal Government. Joshua D'Esposito is the Project Engineer (P.W.A.).

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Procedure Control in Metallic Arc Welding*

By O. T. Barnett†

As we get further along into the Defense Program the haze that surrounded our early operations clears enough for us to see two primary objectives in metallic arc welding. First, as always, the arc welds that we produce must be of the highest possible quality. Second, and this is not necessarily a new consideration either, it behooves us to get the most out of each man-hour of labor expended on welding.

Thus the present-day conception of procedure control assumes that the welding engineer, the welding supervisor and the plant foreman are all familiar with the fundamental characteristics of welding electrodes. Unless the supervisory personnel has a thorough groundwork in electrode performance, the best application of the various types of electrodes becomes a matter of guesswork rather than one of sound engineering.

By this time almost everyone is familiar with the Tentative Specifications for Iron and Steel Arc Welding Electrodes bearing the serial designation A233-40T which is sponsored by the AMERICAN WELDING SOCIETY and the American Society for Testing Materials. Since this discussion will be restricted to the use of electrodes for the welding of mild steels with a tensile strength of 55,000 to 65,000 psi. or for the welding of very low alloy or high-strength steels with tensile strengths varying from 65,000 to 82,000 psi., only the two major classifications of the specification must be considered. These are the first group in which the electrode classification numbers begin with E70 and the second group in which the numbers begin with E60. These prefixes have a definite meaning. E70 means that the minimum tensile strength in the stress-relieved condition is 70,000 psi. while the E60 means that the tensile strength in a similar condition has a minimum of 60,000 psi.

In the main our discussion will center about electrodes in the E60 series with further subdivision into the types of service for which the several classification numbers are best adapted.

Thus we will find that electrode classification number E6010 as may be seen from Table 1 produces fillets with a flat contour. The same is true of the E7010 electrodes which, except for the tensile strength and ductility, call for the same requirements as the E6010 electrodes. Following our plan further we find another group of numbers that yield convex fillet-weld contours while fillet welds of the last two groups both have concave surfaces.

Considering these electrode classification numbers on still another basis we find that the very best physical properties are produced by the electrodes whose classification numbers end in 20 or 30. A study of Table 2 will show that this is the case in both the E60 and E70 series.

The next best physical properties are to be expected from those electrodes whose classification number ends in 10. And, in general, the poorest over-all tensile properties will be found with those electrodes whose classification numbers end in 11, 12 or 13. Not much attention will be paid to those electrodes of the E6013 type as they represent a very small percentage of all electrodes consumed.

However, before leaving this matter of electrode classification it may be well to look at some further restrictions upon our use of these electrodes. If our primary interest lies in a weld of the very finest quality, our choice is almost necessarily restricted to the electrode whose classification number ends in either 20 or 30. We may, as a matter of fact, consider that there is little or no distinction between the 20 and 30 classification, but on some of the lighter gages, as will be shown later, an electrode that is of the E6020 class may have a somewhat better performance. This performance is associated with certain characteristics of the electrode coating. As these two types require welding in either the horizontal fillet position or the flat position, we must acknowledge those limitations. This means that if the highest type of welding must be done in either the vertical or overhead position, we may have to put our entire reliance upon the electrodes whose classification number ends in 10. As soon as we do this, we forego certain advantages that are germane to the flat position electrodes. With the latter our quality welds are often made with electrodes as large as $^{5}/_{16}$ in. in diameter. Not so with those electrodes whose numbers end in 10. Here to obtain the highest quality possible we have to confine our choice of electrode diameters to a maximum of $^{3}/_{16}$ in. for vertical and overhead welding.

We know that many single-pass fillet welds are being produced with electrodes of the ending number 11 or 12 which give adequate physical properties for the services for which they have been chosen. We realize that better

TABLE I—RELATIONSHIP OF ELECTRODE CLASSIFICATION NUMBER TO CONTOUR OF FILLET PRODUCED.

ELECTRODE CLASSIFICATION NUMBER	CAPABLE OF PRODUCING SATISFACTORY WELDS IN POSITION SHOWN	CONTOUR OF FILLET WELDS
E6010-E7010	F, V, OH, H	FLAT
E6011-E7011 E6012	F, V, OH, H	CONVEX
E6020-E7020	H-FILLETS, F	CONCAVE
E6030-E7030	F	CONCAVE

* Presented at the December 16th Meeting, York-Central Pennsylvania Section, A. W. S.

† Engineer of Tests, Metal & Thermit Corp., Jersey City, N. J.

TABLE II—TENSILE REQUIREMENTS OF DEPOSITED METAL

ELECTRODE CLASSIFICATION NUMBER	CAPABLE OF PRODUCING SATISFACTORY WELDS IN POSITIONS SHOWN	GENERAL DESCRIPTION	TREATMENT OF WELDED SPECIMEN	TENSILE REQUIREMENTS MATERIAL DEPOSITED FROM 5/32, 3/16 & 7/32 IN. ELECTRODES	
				TENSILE STREGTH MIN. PSI.	ELONGATION IN 2 IN. MIN, PERCENT
E7010	F,V,OH,H	HEAVY COVERING, USEFUL WITH D.C. ELECTRODE POSITIVE ONLY.	SR NSR	70,000 75,000	22 17
E7011	F,V,OH,H	HEAVY COVERING, USEFUL WITH D.C. EITHER POLARITY. OR WITH A.C.	SR NSR	70,000 75,000	22 17
E7020	H-FILLETS,F	HEAVY COVERING, USUALLY USED WITH ELECTRODE NEGATIVE OR A.C. FOR FILLETS OR ELECTRODE POSITIVE OR A.C. FOR FLAT WELDING.	SR NSR	70,000 75,000	25 20
E7030	F	HEAVY COVERING, USUALLY USED WITH ELECTRODE POSITIVE D.C. OR WITH A.C.	SR NSR	70,000 75,000	25 20
E6010	F,V,OH,H	HEAVY COVERING, USEFUL WITH D.C. ELECTRODE POSITIVE ONLY.	SR NSR	60,000 65,000	27 22
E6011	F,V,OH,H	HEAVY COVERING, USEFUL WITH D.C. EITHER POLARITY OR WITH A.C.	SR NSR	60,000 65,000	27 22
E6012	F,V,OH,H	HEAVY COVERING, USED USUALLY WITH ELECTRODE NEGATIVE D.C. OR A.C.	SR NSR	60,000 65,000	22 17
E6013	F,V,OH,H	HEAVY COVERING, USUALLY USED ON A.C.	SR NSR	60,000 65,000	22 17
E6020	H-FILLETS,F	HEAVY COVERING, USUALLY USED WITH ELECTRODE NEGATIVE OR A.C. FOR FILLETS, AND ELECTRODE POSITIVE OR A.C. FOR FLAT WELDING.	SR NSR	60,000 65,000	30 25
E6030	F	HEAVY COVERING, USUALLY USED WITH ELECTRODE POSITIVE ON D.C. OR WITH A.C.	SR NSR	60,000 65,000	30 25

physical properties and somewhat more sound welds might be expected from those electrodes that produce either concave or flat fillets. Better multiple pass welds fundamentally can be made with these latter electrodes also. Still the strength and soundness of the convex fillet welds has proved to be ample for the many uses to which the electrodes that produce this contour have been put. Thus a sequence of choice based upon operating conditions and physical results desired can be made.

Sometimes there is a question as to the type of current that should be used. Should this current be alternating current or direct current? Or if direct current is decided upon, should the polarity be straight or reverse? And what is the effect upon the deposition rate when one or another current type and polarity is selected? Figure 1 shows actual values obtained on experimental electrodes conforming to the requirements of Grade E7011, which grade is suitable for use with direct current either polarity or with alternating current. From this figure we can see that the straight polarity deposition rate is better than that of the reverse polarity condition. Furthermore, the alternating-current deposition rate appears to lag behind rather badly. Looking at this without any further information might lead us to both false and superficial conclusions.

Sometimes straight polarity is the best condition for fillet welds while oftentimes reverse polarity is the best condition for butt welds. At times the shape of the weld and the penetration of the bead may be changed by changing the polarity. Furthermore, alternating-current electrodes are always used at higher currents than the direct-current counterparts. Or put in another way, it is possible to use more current with a.c. so that the resulting deposition rate at the increased current is very likely to fall in line with the values reported for either straight or reverse polarity. And touching upon the make-up of the electrode coating, a.c., in some applications, may lead to better deposition rates than d.c. with either polarity. If our procedure control is to work properly, we should specify both the type of current and the polarity, being guided always by recommendations of the electrode manufacturer. Experience dictates the type of current and polarity that should give the highest quality of deposit at the lowest cost of application. The example used for Fig. 1 employed an electrode that works well on either direct or alternating current; nor was there any other restriction as to the type of polarity that could be selected. However, many electrodes have current and polarity conditions established by coating compositions. The most noticeable of this group are those electrodes that produce a flat fillet-weld contour among which grades E6010 and E7010 are well-known examples.

What about the diameter and length of electrode that we would like to use? Some people feel that the largest electrode possible should always be used even when this electrode must be operated at extremely low currents. Others think that the best economy will result when a smaller electrode is used at the highest possible currents. In Fig. 2 are shown the deposition rates of the various

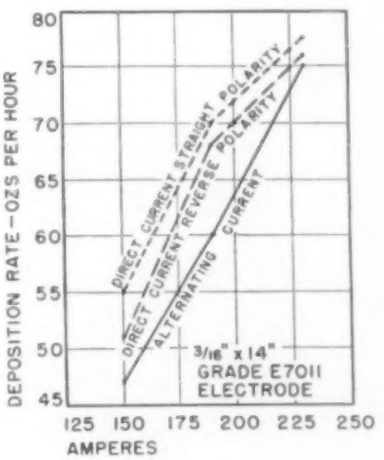


FIGURE 1 — DEPOSITION RATE AS A FUNCTION OF TYPE OF CURRENT AND POLARITY

sizes of electrodes as a function of increasing diameter. From a study of this figure, it is quite apparent that the $^{7}/_{32}$-in. electrode at 350 amp. has a deposition rate of 123 oz./hr. The $^{1}/_{4}$-in. electrode at 300 amp. has a deposition rate of 115 oz./hr. Under these conditions it is possible to get more production out of the smaller diameter electrodes. Normally, however, the greater the diameter with proper current, the higher is the resulting deposition rate.

Moreover there are *laws* governing the choice of electrode diameter. Very often the heat capacity of the joint determines the diameter of the electrode that can be used. Following this is yet another consideration: soundness of deposit, that influences the diameter of the electrode to be selected. It is the quality factor that usually leads to a maximum electrode diameter of either $^{5}/_{32}$ in. or $^{3}/_{16}$ in. for vertical or overhead welding. Likewise, the avoidance of undercut on horizontal fillet welds suggests a maximum diameter of $^{1}/_{4}$ in. for grade E6020. So a ready rule for determining electrode diameter is, first, know the heat capacity of the joint and, second, respect the inherent limitations of the desired type of electrode.

Whenever there is a choice that can be made regarding the length of the electrode, the longer electrode will give the higher deposition rate. Another bonus can be realized from the fact that fewer stubs per number of rods deposited will lead to a greater efficiency of electrode consumption. Figure 3 points out the relationship between deposition rate of the $^{1}/_{4}$ x 14-in. and $^{1}/_{4}$ x 18-in. electrodes. Of course, it is not possible to use 18-in. electrodes in the smaller diameters such as $^{3}/_{32}$ in. and $^{1}/_{8}$ in. Even at normal currents the last several inches of the small diameter electrode may become overheated and thus useless.

Now we can apply some of the information we have already obtained. Let us pretend that we wish to make a $^{3}/_{16}$-in. fillet weld joining $^{1}/_{4}$-in. plates. At the same time we shall attempt to get the best combination of electrode diameter, current and arc voltage for the heat capacity of the joint. Figure 4 shows the deposition rates that can be expected in our theoretical setup.

The poorest deposition rate is that resulting from the use of the $^{5}/_{32}$-in. grade E6010 electrode. The diameter restriction here is due to the deep penetrating quality of this electrode which results in a high thermal input in a joint with rather low heat capacity. Next comes the grade E6030 electrode which permits the use of a higher current and a greater speed of travel in the straight polarity d.c. condition specified. Then comes the grade E7011 electrode where a tremendous jump in deposition rate comes about because of the use of a larger diameter electrode with a lower arc voltage having lesser penetrating properties. Here a small increase is observed with grade E6012 type and a slightly lower arc voltage may be noted. The best result is obtained with the grade E6020 electrode where an appreciably higher current with a faster rate of travel may be successfully specified. Because of the special properties of the coating, on light work the grade E6020 electrode has some advantages over the E6030 electrode. So much for the $^{1}/_{4}$-in. joint with low heat capacity.

Now let us consider a similar situation in which 1-in. plates are jointed with a $^{1}/_{2}$-in. fillet. The difference between this setup and the preceding one is obviously a question of heat capacity of the joint.

Once more the grade E6010 electrode has the poorest showing. This is so because we wish a very good quality weld and have restricted our electrode diameter to $^{3}/_{16}$ in. for this reason. The grade E6012 electrode which is fundamentally colder gives a marked increase due to the use of the larger diameter with more current. Next comes the grade E6020 electrode which is only slightly better than the E6012 electrode in this larger diameter with more current permitted by a sufficient heat capacity in the joint. Finally grade E6030 electrodes using a little more current and a slightly higher voltage bring about a remarkable increase in deposition rate.

There is more to procedure control than being able to select a proper electrode for the joint to be welded. Certainly the design of the joint itself merits considerable attention. This matter is best taken care of by having a welding engineer, or the man who performs the duties of the welding engineer, whatever his title may be, coordinate activities of the plant and the engineering department. Often the best of engineers find it difficult to translate the designs of the drafting board to actual shop conditions under which the welders must work. Frequently simple modifications in joint designs may be pointed out by the welding engineer while the weldment is still on the drawing board. Minor changes at this point can lead to impressive cost savings.

The question of procedure control does not stop with coordination of plant and engineering activities. Since the weld is the final answer to all of the investigations that have gone before, sufficient attention must be paid to the activities of the welders. Some scheme must be devised to bring about good control of all welding activities. Recording meters that record fluctuations in welding performance, such as the Arcronograph or recording ammeters and voltmeters, have proved themselves to be helpful in studying the performance of individual welders.

FIGURE 2 — DEPOSITION RATE AS A FUNCTION OF ELECTRODE SIZE

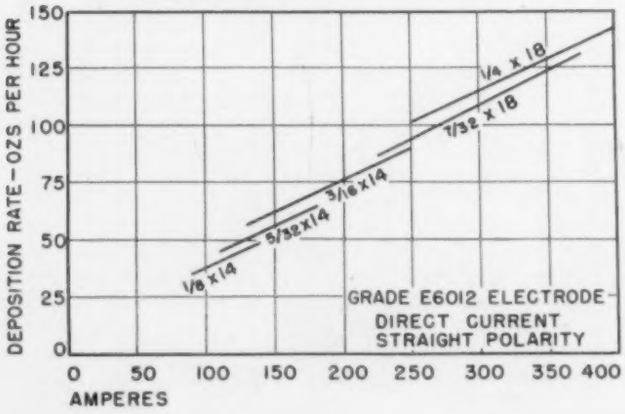
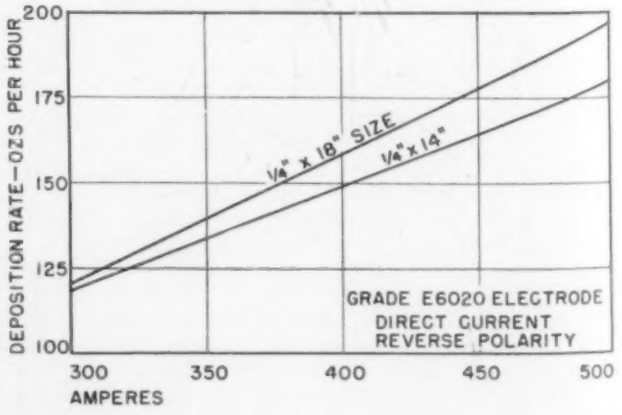


FIGURE 3 — INFLUENCE OF ELECTRODE LENGTH ON DEPOSITION RATE



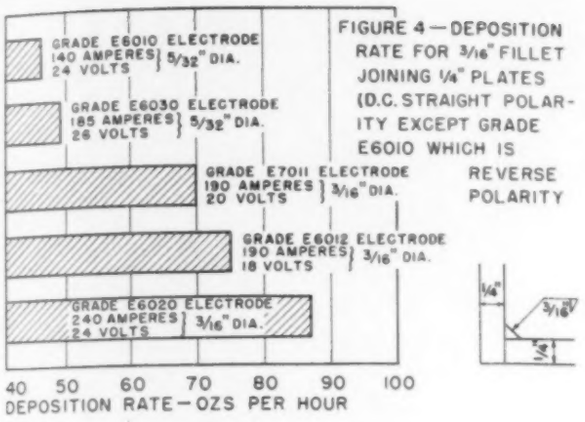


FIGURE 4—DEPOSITION RATE FOR 3/16" FILLET JOINING 1/4" PLATES (D.C. STRAIGHT POLARITY EXCEPT GRADE E6010 WHICH IS REVERSE POLARITY

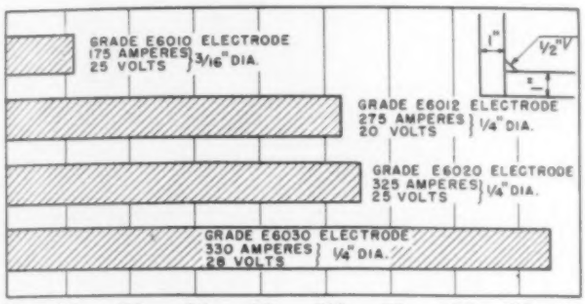


FIGURE 5—DEPOSITION RATE FOR 1/2" FILLET JOINING 1" PLATES (D.C. STRAIGHT POLARITY EXCEPT GRADE E6010 WHICH IS REVERSE POLARITY)

These instruments are designed for investigations of the quality factors of welding. Similar instruments are available to measure the operating factor or amount of time that the welder is actually maintaining an arc. One instrument uses 20 pens to record operating times in twenty separate welding circuits with the arc going as little as 20% of the time. In many welding operations the advantages of arc time studies to maintain production rates are quite pronounced. The very presence of a recording device has served to increase welding factors in some plants.

Now that the technical and supervisory angle of welding has been more generally recognized the welder is expected to make fewer decisions than was formerly the case. Detailed procedure sheets are made up to cover the most common joints and welding methods. Where definite types of steels are welded, specifications include, in addition to welding electrode specifications and detailed procedures regarding current, voltage and size of electrode, data for preheating and postheating operations where these are necessary.

Welding has made remarkable strides in the last decade. In this period we have seen welding make a complete change from an art to a science. The fine service given by the AMERICAN WELDING SOCIETY in bringing about a better technical understanding of the fundamentals of welding has been widely and properly acclaimed. Today qualified welding engineers outline procedures that make excellent welds at economical cost a matter of daily routine. Since there is much to be gained by the application of procedure control to the welding processes, the advantages of such a practice cannot be overlooked. More and more concerns are turning to welding for the most advantageous manufacturing methods. The ones with the most comprehensive procedure control constructed from sufficient knowledge of basic welding principles are bound to come out on top when the current business boom is ended and competition becomes very keen once again.

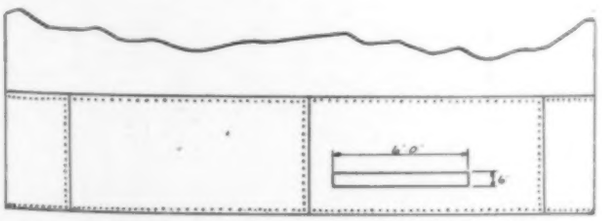
Repairing Storage Tanks

By Robert Wagner*

WAR has made it imperative to place all storage or working tanks used in the petrolem industry back into active service immediately. Given below in complete drawings is the effective method used by E. G. Woolman, welding foreman,[1] Cities Service Oil Company, Ponca City, Okla., for reconstructing tank bottoms by arc welding.

* Hobart Brothers Co., Troy, Ohio.

[1] This is a prize-winning entry in an arc-welding news contest sponsored by Hobart Brothers Co., Troy, Ohio.



SIDE OF TANK, SHOWING SECTION TO BE CUT OUT TAKING PLACE OF DOOR SHEET

Fig. 1

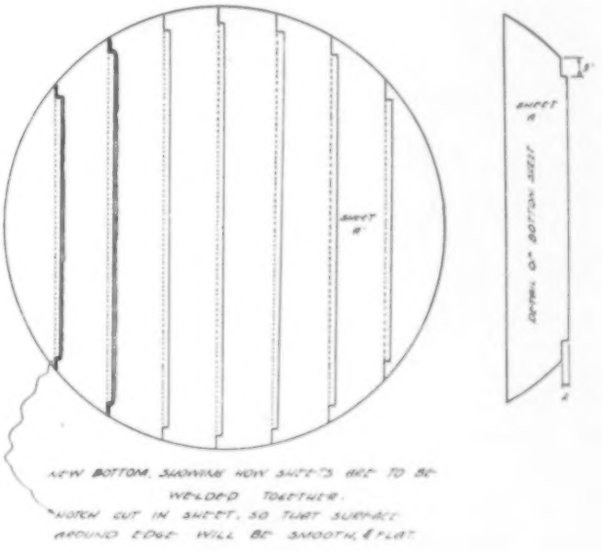

SHEET A
SHEET B
NEW BOTTOM, SHOWING HOW SHEETS ARE TO BE WELDED TOGETHER.
NOTCH CUT IN SHEET, SO THAT SURFACE AROUND EDGE WILL BE SMOOTH & FLAT.

Fig. 2

These tanks—used for gasoline, naptha, kerosene, gas oil and crude oil—had leaky and corroded bottoms. Steaming, of course, was first necessary to remove all vapors and oil so that a possible fire or explosion may be prevented. Old bottom was cleaned, after steaming, with fuller's earth. Material was moved inside of tank

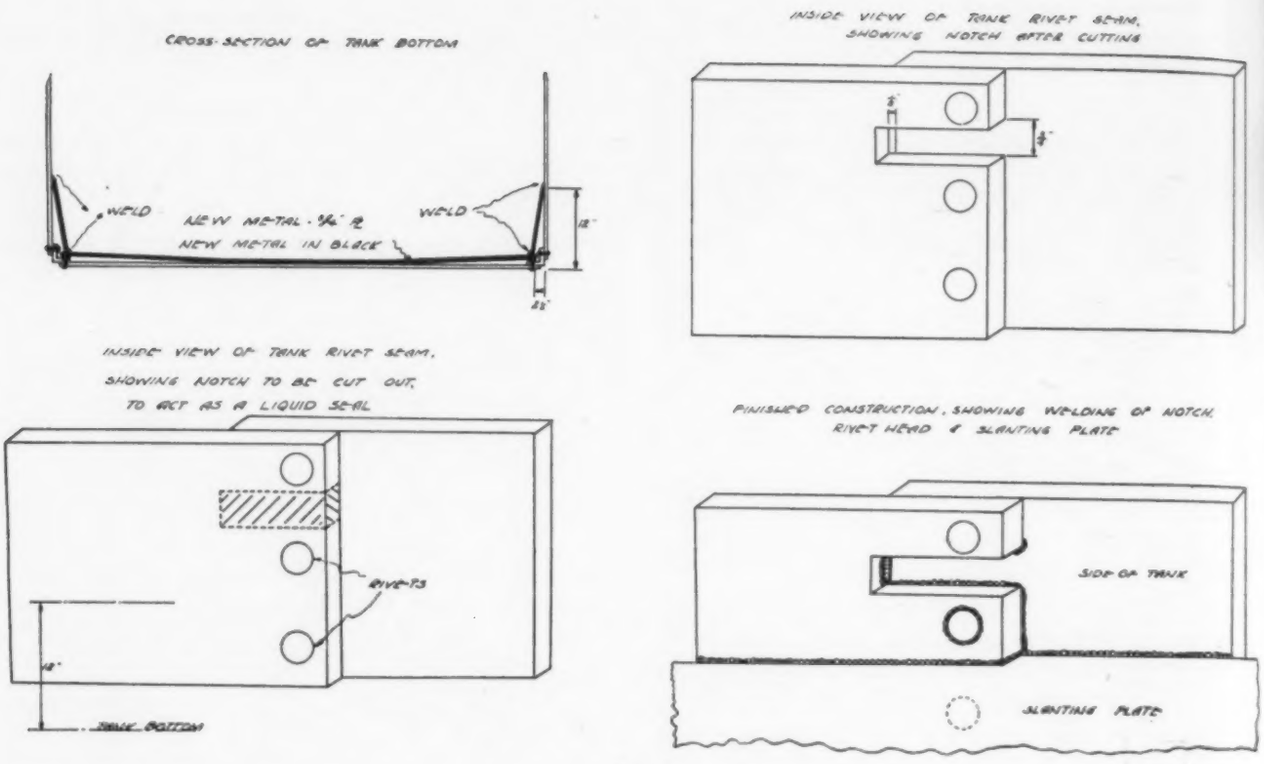


Fig. 3

without taking out a door sheet by cutting a 6 ft. x 6 in. section out of the side of the tank near the bottom.

Drawings show clearly the actual method or reconstruction. Details of the bottom in Fig. 2 illustrates how each plate overlaps—except by 3 in. at each end. At each end, the notch is butt welded to the adjoining sheet, forming a smooth and flat surface around the edge. Only one pass with a $^3/_{16}$-in. mild steel rod was necessary.

The 12-in. slanting plate, shown in the upper left-hand corner of Fig. 3, rests on the flat outside surface and is welded to it. Two beads were run at the top and bottom of the slanting plate. Top of the slanting plate was joined to the side of the tank, and the bottom to the new bottom.

At each rivet seam a notch, $^3/_4$ in. high and 3 in. long, was cut out so that the inside of the notch could be welded. (See Fig. 3.) This prevented any liquid from seeping in back of the rivets, running down the seams, back of the slanting plate or underneath the new bottom.

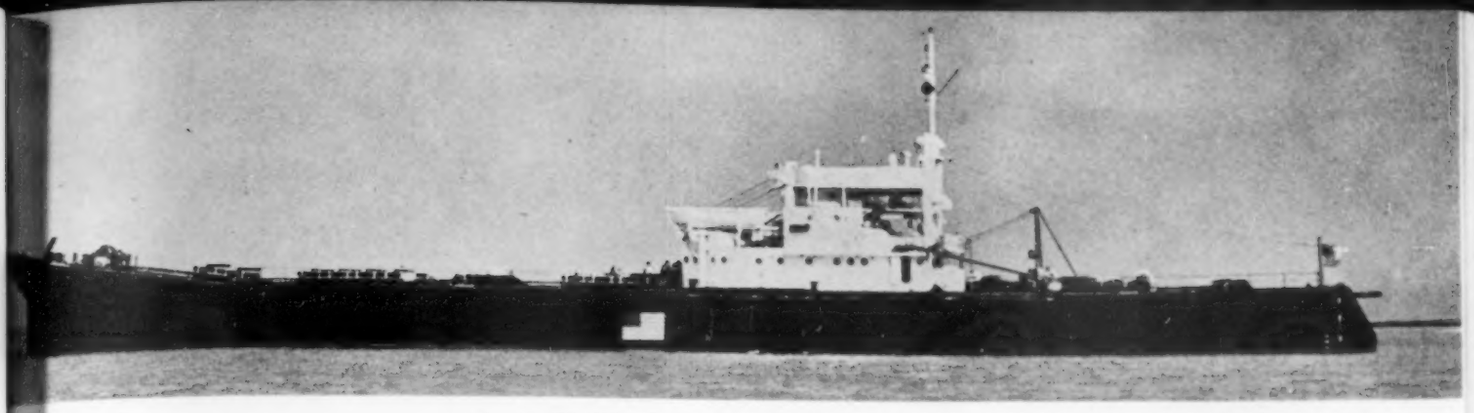
After the new bottom was installed, the section cut out to act as door sheet was welded back into place. There is no need to make this weld tight since it has been cut below where the slanting plate on the inside has been welded liquid-tight.

Cost figures for a 52,000-gal. tank were $576.68. This cost of constructing by arc welding is $230 under cost of fabricating and installing a new riveted bottom. Cost figures include both labor and material.

Corrosion has always been most severe around the bottom angle iron and old rivets—even extending sometimes 3 or 4 in. up on the sides of the tank. This method of reconstruction by arc welding will prevent such corrosion and form a new bottom that will not pull or break away from the sides, since the liquid is free to work around due to the slanting plates.

SETS OF BOUND VOLUMES OF JOURNAL

In order to provide some of the new members of the Society with an opportunity to complete their library on Current Welding Literature, the AMERICAN WELDING SOCIETY is offering to these new members an opportunity to purchase the last nine bound volumes for the years 1933, 1934, 1935, 1936, 1937, 1938, 1939, 1940, and 1941 at $40.00 a set plus postage. The price to non-members for individual volumes is $6.50 and for the set $45.00 plus postage.
Each bound volume contains a Subject and Authors' Index and is bound in attractive imitation black leather covers. The set probably includes the most important welding information available in the literature.



The Arc-Welded Cargo Ship, *Sea Otter II*

Three Interesting Arc Welding Applications

By A. F. Davis*

I. Experimental Blockade-Breaking Cargo Ship Is Arc Welded for Speed and Strength

CONSTRUCTION of the *Sea Otter II*, novel experimental cargo carrier developed by the U. S. Navy Department as a possible answer to the submarine threat, was made possible by use of electric arc welding, used exclusively in the fabrication of the hull and other steel parts.

This unusual ship (see illustration), which has undergone exhaustive tests by the Navy Department, represents an attempt to reduce shipbuilding to real quantity production by great simplification of the hull design and by application of arc welding to speed production. Tests were so successful that the Navy Department has formed a corporation to build this type of vessel exclusively.

Although the details of the ship, and the plans for utilization of a fleet of them if further tests prove successful, are clouded in secrecy, some very interesting things are known about the *Sea Otter II*.

Orginally, it was intended that the ships should have no permanent hatches whatsoever in the hull to provide for admission and removal of the cargo. It was proposed that a new type of simple hatch cover was to be securely arc welded in place and cut off without danger to the cargo. Then it could be rewelded in place.

The ship test proved so successful that it was decided to use the ships on round trips, and the *Sea Otter II* and all future ships of this design will have permanent hatches but, it is understood, not of the conventional type. A radical departure in hatches is reported.

The ship's 16 gasoline engines also will be left permanently in the ships, rather than taking them out and dismantling the ship as had been first suggested. These changes all were made because of the extraordinary good results obtained in test runs.

The first *Sea Otter II* was constructed by the Levingston Shipbuilding Company of Port Orange, Texas. The vessel, which has a length of 250 ft., beam of 40 ft. and depth of 21 ft., is of all-welded construction employing strip steel from universal rolling mills. They require no bending or rolling except at the bilges. The simplicity of the design, plus the fact that arc welding was used for speed and strength, permitted launching of the vessel in six weeks' time at a cost of $250,000. It is expected that this production time may be reduced still further if more ships are built. Produced in quantity, cost should not be more than $150,000 apiece fully fitted out.

The main hull plates are of $^3/_8$-in. steel and the flat keel is constructed of $^1/_2$-in. plates. The bottom side and deck plates are stiffened with longitudinal stiffeners. There are no transverse ribs or frames except intercostals, which are used to stiffen the longitudinals every ten feet. Nine transverse watertight bulkheads were welded inside the hull.

The draft of the ship is 11 ft. fully loaded and it is thought that this, plus the fact that the *Sea Otter II* sets relatively low on the water and is far less visible than other types of cargo carriers, will make the ship a poor target for a submarine. It is well known that a torpedo must be set at a depth which insures its run being free of wave effect, or for ocean going setting considerably more than 11 ft.

The vessel in loaded condition is so low in the water that in heavy weather at sea her decks will be awash most of the time. Arc-welded construction was utilized to enable the craft to withstand this strain, plus the shock of possible near-hits, better than other types of construction, because it has been proved that welded plates only buckle rather than split at the seams.

The ship is propelled by 16 automobile engines of 110 hp. apiece. These are arranged radially and coupled hydraulically 4 to a propeller and the 4 propeller shafts descend vertically into the water in much the same manner as outboard motors, except that the transmissions are inside of cylindrical wells. However, the propellers of the *Sea Otter II* are located just aft of amidships. The motors and propellers may be lifted into the vessel for repairs while under way and spare propellers and engines will be carried. The ship is equipped with degaussing mechanism for magnetic mine protection.

The ship has a cruising radius of 7000 to 9000 nautical miles and a sustained speed of 12 knots. For short cruises, however, the vessel has subdivided tanks to carry 95 tons of fuel and will have a cruising range of 3700 miles at 12 knots. She has a hold capacity of 122,800 cu. ft.

It is hoped that large numbers of the ships built in quantity production with arc welding will break entirely Hitler's blockade of the British Isles.

* Vice-President, The Lincoln Electric Company, Cleveland, Ohio.

Fig. 1—Swiveled Brackets on the Side of This Trailer Chassis Permit Extension of the Trailer Bed to Increase Its Area. They Are Shown in Their Extended Position Here

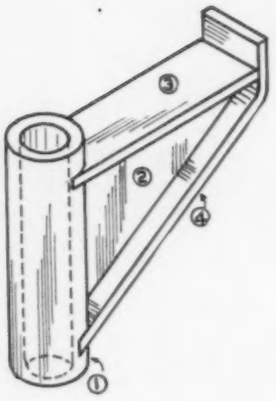


Fig. 3—Old Type of Trailer Extension Bracket

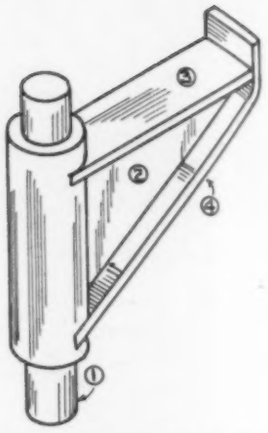


Fig. 4—New Arc-Welded Construction of Trailer Bracket

II. Simplified Arc-Welded Bracket Saves Time and Cost

PROGRESS in all things is made by forward-thinking men who, never content with things as they are, continually seek to better existing methods and designs.

Improvements which result from this type of thinking sometimes are big. More often, however, they are small but numerous, and the total contribution of small improvements is just as great as that of the major changes.

An example of such a simple change in design, which saved time and money for the Roger Brothers Corp. of Albion, Pa., is an arc-welded trailer extension bracket used to widen the trailer.

The brackets are attached to the side channels of the arc-welded trailer chassis, as shown in Fig. 1.

The brackets of previous construction as shown in Fig. 1 are in their extended position ready to receive a heavy plank to widen the bed.

Fig. 2—Completed Trailer Chassis with Extension Brackets Folded Back Into Position. Improvement in the Design of These Brackets Saved Time and Money

Figure 2 shows a completed trailer with the brackets folded back into position.

The massiveness of the loads which this trailer must carry is indicated by the fact that eight pairs of wheels are used. The steel chassis and the extension brackets must be extremely sturdy to bear the weight. Arc welding, which permits both strength and lightness in construction, did the trick.

The first improvement in the brackets was made by arc welding them of four pieces, as shown in Fig. 3. This construction employed a piece of heavy steel tubing (1) through which a swivel pin was run. A triangular plate (2) and two pieces of steel bar (3) and (4) were arc welded as shown to complete the bracket.

This represented a great improvement over the previous construction, but the Rogers Company engineers were not content to accept this as a final design. They found that they could eliminate the swivel pin by using the construction shown in Fig. 4. The bracket, although still comprising four pieces, incorporates the swivel pin in the bracket. The heavy piece of round stock (1) was substituted for the tubing shown in Fig. 3 and its ends machined to form the swivel.

Figure 5 shows how the brackets are used to widen a trailer. A plank is placed on the brackets after they have been swung out, thus increasing the effective width. The brackets must be strong enough to support the heavy loads for which the trailers are designed.

The new bracket is easier to install on the trailer than the old design and time is thus saved. In addition, it is more rigid than the other type.

The new bracket is lower in cost because shafting was substituted for tubing and a separate swivel pin eliminated.

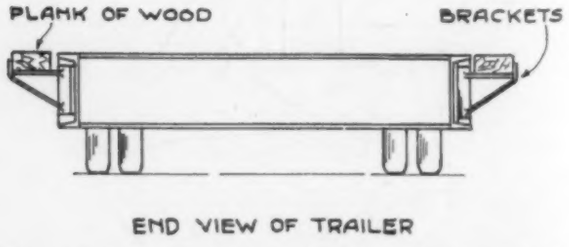


Fig. 5—How the Brackets Are Used to Widen the Bed of a Trailer. When Swung Out, the Brackets Will Support a Plank as Shown, Thus Increasing the Effective Width of the Trailer

III. Arc Welders Work Out Method for Removing Broken Stud Bolts

MOST welders have a deep-seated conviction that they can accomplish almost anything in the way of construction or repair by means of the electric arc. No exception are two New York welders, who worked out a welding solution to the old machinist's problem of removing broken stud bolts.

The new method, according to welders Alex F. Morton, Brooklyn, N. Y., and William F. Kramer, Bronx, N. Y., is 20 times as fast as the old. They found it so successful in every application that they believe they would be contributing greatly to the war effort by making the method known to maintenance officials and workmen everywhere, in order that industrial production or military operations will be interrupted as little as possible in event of necessary equipment repair requiring removal of broken studs.

The two welders observed that a good machinist could remove only about one broken stud an hour by drilling out the inside, breaking out the thin shell which remained and then re-tapping the hole. In cases where the hardened stud bolt was broken off at an angle, much more time was required by the old procedure.

The welders worked out the following methods which they recommend highly to their fellow welders:

Lay a nut, whose inside diameter is slightly greater than the outside diameter of the broken stud bolt, directly above the bolt. Build up the stud by means of beads to the nut and weld it firmly in place. The stud then may be removed by means of an ordinary wrench—at the rate of about 20 an hour!

In some cases, where there is only one isolated stud, it may be necessary to heat the area around the broken stud to expand the hole and permit removal.

In other cases, such as the group of broken studs shown in the wheel carrier in Fig. 1, it is suggested that all the nuts be welded on in succession. The accumulated heat generally permits removal of the stud with the ease normally found in the removal of an ordinary nut.

A group of studs removed by this time-and-cost saving method is shown in Fig. 2. The large bolt at the left of the photograph was exceptionally difficult to remove. It was frozen into a tractor bracket and the top of the $1^{3}/_{16}$-in. bolt was $^{5}/_{16}$ in. below the surface. After welding the nut on by means of the electric arc, the area surrounding the bolt was heated to a full red heat, according to the welders, and the bolt then backed out with a 30-in. Stillson wrench. This attests to the strong character of a good arc weld.

Fig. 1—This Type of Work Formerly Went to the Machine Shop. However, Two New York Welders Found That They Could Do It 20 Times As Fast by Welding

Fig. 2—Five Broken Stud Bolts Licked by the Electric Arc. Welding Nuts to the Studs Did the Trick

Others of those shown in this illustration were as much as $^{5}/_{8}$ in. below the surface.

"The elimination of broken drills and the releasing of machinists for other work result in a greater output all around," Morton said. "Of course, occasionally more than one nut must be welded to the stud, but they usually all are removable by this method, regardless of the depth below the surface that the stud is broken off."

WELDING « Codes, Standards and Specifications

Code for Arc and Gas Welding in Building Construction—1941 Edition	50c
Standard Qualification Procedure—1941 Edition	40c
Welding Symbols and Instructions for Their Use—1942 Edition	25c
Definitions of Welding Terms and Master Chart of Welding Processes—1942 Edition	40c
Standard Methods for Mechanical Testing of Welds—1942 Edition	40c
Tentative Specifications for Iron & Steel Arc Welding Electrodes—1940 Edition	25c
Specifications for Welded Highway and Railway Bridges—1941 Edition	Members 75c Non-members $1.00
Rules for Field Welding of Steel Storage Tanks—1940 Edition	25c
Rules for Fusion Welding Steam, Oil or Air Piping in Marine Construction—1938 Edition	25c
A. W. W. A.-A. W. S. Standard Specifications for Elevated Steel Water Tanks, Standpipes & Reservoirs—1941 Edition	30c
A. S. M. E. Code for Unfired Pressure Vessels—1940 Edition (Note: A. W. S. cooperated in preparation of Rules for Fusion Process of Welding)	$1.50 + postage
A. P. I.-A. S. M. E. Code for Unfired Pressure Vessels for Petroleum Liquids and Gases—1938 Edition	$1.25 + postage

American Welding Society . . . 33 West 39th Street . . . New York City

Temperature Data

This Useful Chart Includes Melting Points and Other Temperature Data

By George Sykes*

THE accompanying chart not only lists the melting points of various alloys and metals but also serves as a convenient means for conversion between Centigrade and Fahrenheit temperature scales. In addition, on the far right of the scale are shown the color designations that are commonly used in judging the temperatures of hot metal by color.

Melting Points

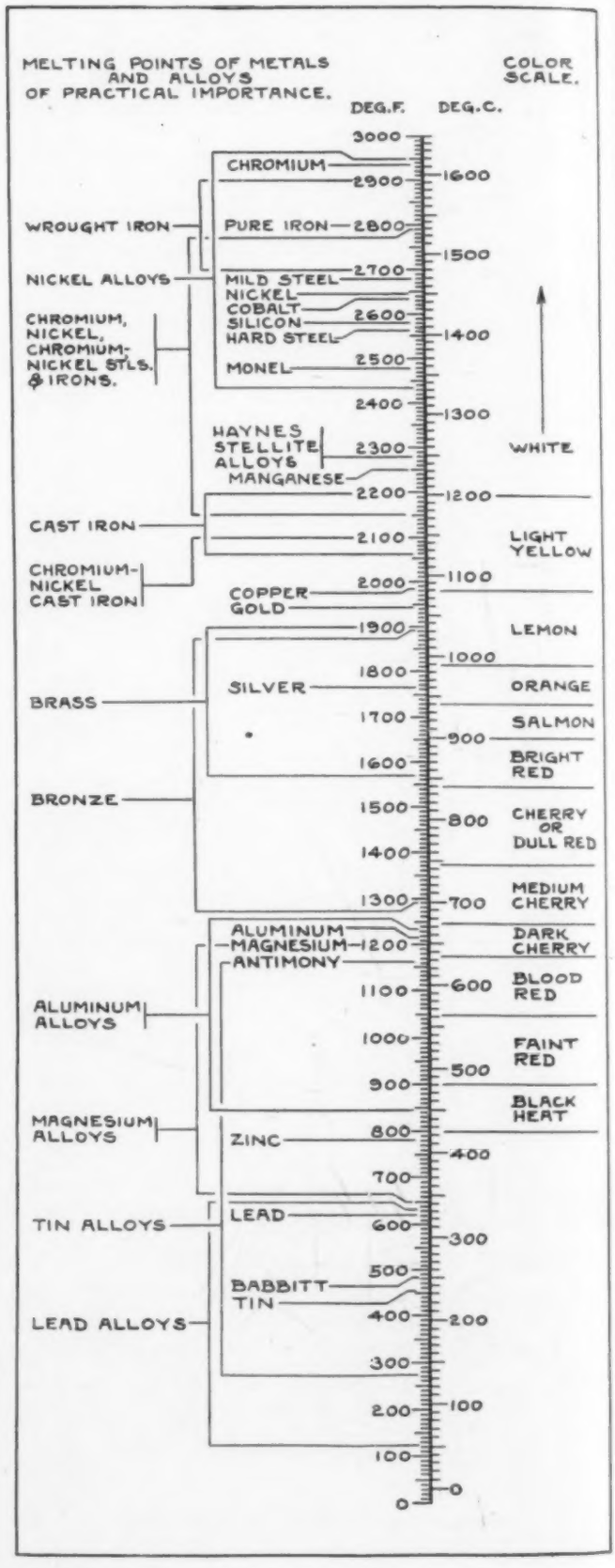
This chart should prove useful to all welding operators for it contains basic information on working with metals at elevated temperatures. Reference to the chart, for instance, shows why aluminum and aluminum alloys, because of their low melting points, give little or no indication by change in color when they approach welding heat. On the other hand, the high melting point of wrought iron explains why considerably more heat is required to weld this metal than is required for cast iron, for instance.

Temperature Color Scale

Another use for the chart is in estimating the temperature by color. For instance, instructions may require that the part be preheated to 1100° F. before welding. If you are without a thermocouple or other means for accurately measuring high temperatures, reference to the chart shows that the part, at 1100° F. would have a blood-red color. With a little experience, you can estimate this fairly closely by eye. In this connection, it should be mentioned that the color scale is for observations made in a fairly dark place and without welding goggles. As the light increases, the color groups on the scale will apply to higher temperatures.

Conversion Data

Finally, the chart is a ready means for converting Fahrenheit to Centigrade, and vice versa. Suppose you are familiar with the Fahrenheit scale, yet instructions call for the quenching of a welded part from 900° C. Reference to the chart shows this to be approximately 1650° F.



* The Linde Air Products Company, New York, N. Y.

Oxyacetylene Applications in Intensified Industrial Program*

By W. S. Walker†

DEVELOPMENTS in the oxyacetylene field have been accelerated to a marked extent during the past two years as a result of the broad industrial demands of the defense program. The old welding and cutting processes have been pressed into new fields, and new uses for the oxyacetylene flame and the cutting-oxygen stream are being achieved. Moreover, the widened and intensified application of the processes has brought about new developments in apparatus, particularly in mechanized apparatus.

These new developments and techniques are naturally finding widest application in the steel, shipbuilding, aircraft and other industries most directly concerned with defense production. Various uses of the process include the maintenance of mill equipment, the repair of damaged ship parts, preparation of plate edges for welding in ship construction, the single and multiple cutting of steel billets for shell forgings, the surface conditioning, descaling and flame-treating of armor plate slabs and steel for other armament requirements, the flame-priming of naval piling and other structures, the shape-cutting and flame-hardening of parts such as tank sprockets, and the welding of vital aircraft structures. Illustrated in the following sections are these and other uses of the oxyacetylene process in defense. Of necessity, this review covers a wide variety of more or less unrelated industries and processes. However, they should serve to give a general idea of how the oxyacetylene flame is used in practically every metal-working branch of defense production.

General Plant Maintenance

In general plant maintenance, it seems almost unnecessary to cite the numerous every-day operations involved in the repair of broken machinery, the renewal of worn parts, the installation of structures, machines and piping, the alteration of equipment and the demolition and scrapping of useless items. However, full-capacity operations and the accompanying lack of stand-by equipment have seriously multiplied the problems of maintenance. Shortages and slow deliveries of heavy equipment have prompted efforts to alter and render serviceable every possible unit of obsolete machinery. Scrap piles are being closely combed and salvaging operations are at a peak. The oxyacetylene processes, through their simplicity and versatility, are found to be increasingly helpful in all of these emergency measures.

A typical quick repair job is illustrated in Fig. 1. The bronze-welded repair of this 13-ton cap casting for a 100-ton press saved a manufacturer a three weeks' shutdown and several thousand dollars for a new casting. After veeing the 14 ft. of cracks in the 4-in. and 6-in.-thick metal, the entire casting was set on I-beams to insure exact alignment, and preheated with charcoal in a firebrick furnace. Almost 400 lb. of bronze welding rod were required for the repair.

Beveling Plate Edges for Welding in Ship Construction

The defense program has greatly stimulated the trimming, shaping and beveling of plates by oxyacetylene cutting not only in all types of fabricating shops but particularly in shipyards. Yards using a combination of cutting and welding are obtaining remarkable production rates, and it is the generally held opinion that the combination of the two processes is one of the most important reasons for the high schedule of ship construction in the United States today. With the growth of the shipbuilding programs, existing methods for beveling plates were found to be entirely inadequate, and a demand arose for oxyacetylene cutting equipment which could be used to produce prepared edges to the required tolerances.

To meet the requirements of the various welding procedures and joint types, it is frequently found necessary to do combination cutting, that is, to prepare the plate edge by simultaneous cutting with two or three blowpipes mounted on a single blowpipe-riding device. Because of the floating feature of this device and the accurate control of the distance between cutting nozzles and plate it is possible to make long special edging cuts with a constant profile on large plates, even if these should be buckled appreciably from the flat position. A close-up of a three-blowpipe cutting operation producing a double bevel with nose is shown in Fig. 2. A number of other popular profiles for welding are readily produced with single- and multiple-blowpipe mountings on riding

Fig. 1—Bronze Welded Repair of a 13-Ton Cap Casting

* Abstract of a paper presented at the Joint Meeting of the AMERICAN WELDING SOCIETY and the American Society of Mechanical Engineers in New York City, November 11, 1941.

† Manager, Process Service, Eastern Division, The Linde Air Products Company, New York, N. Y.

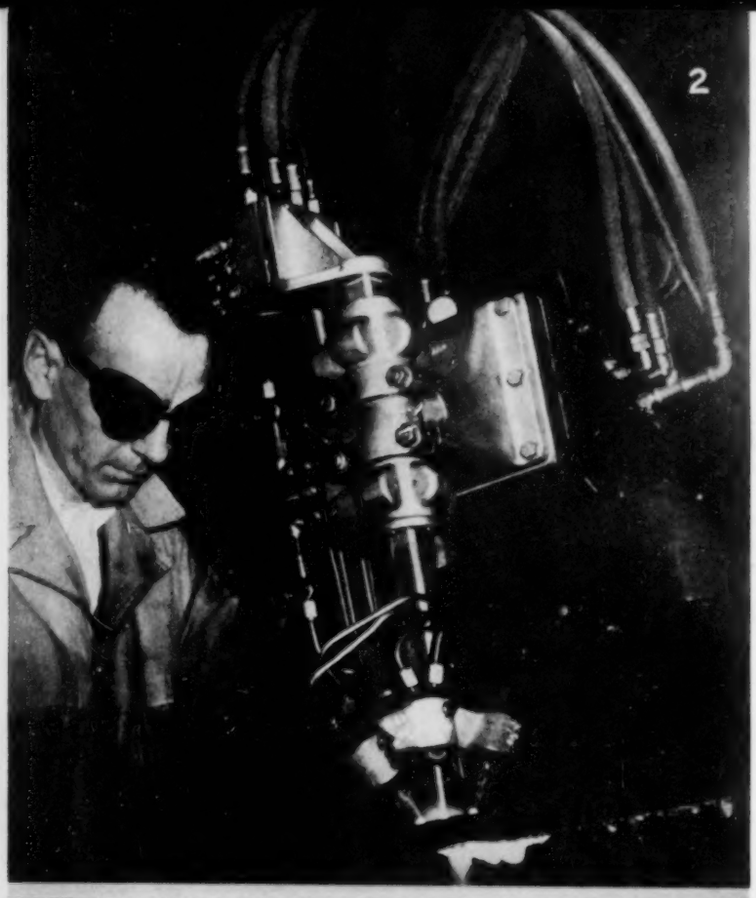


Fig. 2—Producing Double-Bevel with Nose

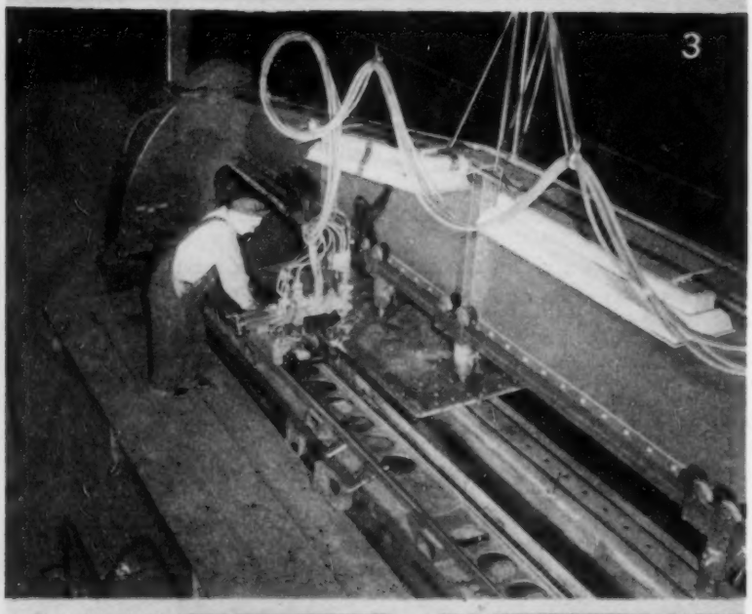


Fig. 3—A Set Up for Beveling Plate in a Shipyard

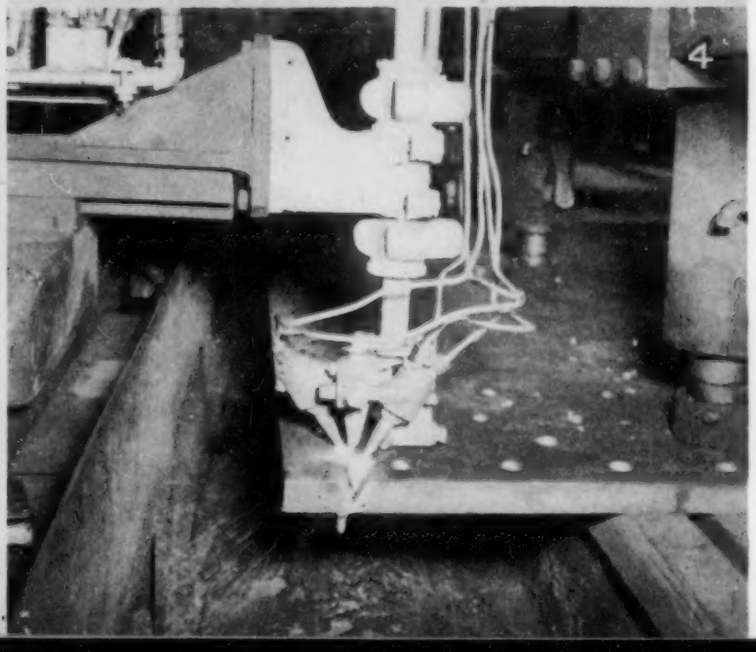


Fig. 4—Double-Beveling Shell-Plate Without Nose

devices of the type shown. Specifically these include straight square edge, single bevel with or without nose, and double bevel with or without nose.

A setup for beveling plate in a shipyard which is now constructing the largest ore carriers ever to be built for service on the Great Lakes is shown in Fig. 3. Practically all the plate for these ships is trimmed to size and beveled for welding by oxyacetylene machine cutting. As shown here, an old 26-ft. planer has been converted into a setup especially for plate-edge preparation. The travel carriage of the planer has been removed and substituted with track for the cutting machine. An interesting feature is that the two tracks swivel at the center and are aligned with the plate to be cut by means of a rack and screw adjustment at each end. Plate is cut at both ends of the planer bed. While one end is being loaded, plate at the other end is being cut. Air jacks hold the plate firmly in position during cutting.

The close-up in Fig. 4 shows the double-beveling of a shell-plate butt without nose. The plate is $1^{3}/_{8}$ in. thick and each angle of bevel is 30°. Cutting speed is approximately 8 in. per min.

Steel Conditioning

Defense applications of the oxyacetylene process in the steel industry include a number of processes essential in preparing the steel for subsequent use. These are the conditioning of the steel by hand or by mechanical means, the hardening or softening of steel surfaces, the removal of scale from the surfaces and the cutting of the steel to proper size and shape.

The acceptance of hand conditioning or hand scarfing, as it is known throughout the steel industry, has been quite general. Both the number of users and the number of scarfing blowpipes have increased at even a higher rate than that of production capacity percentage. No radical changes in the basic process have been developed during the time of the emergency program. A typical hand-scarfing operation on a slab is shown in Fig. 5. The process is used for conditioning steel for shell stock, armor plate and for other ordnance requirements.

By far the greatest development in steel conditioning during the past few years has been in the field of mechanized hot-surface removal. Figure 6 shows a typical flame-scarfing machine installation in a regular blooming mill production line. This particular machine is placed after the blooming mill and adjacent to the billet shear where its operation does not interfere with the mill schedule. The installation is designed to remove the surfaces simultaneously from the four sides of blooms at rolling temperatures and speeds. The possible depths of removal range from $^{1}/_{64}$ to $^{1}/_{8}$ in.

The actual scarfing is accomplished by the application of oxyacetylene flames, as a preheating agent, and oxygen streams, as the metal remover. The preheating and metal-removing gases are applied through mixing devices and nozzles quite similar to those used for oxyacetylene cutting and oxyacetylene hand-deseaming operations. The bloom passes through the center of the machine where it is completely encompassed by four nozzle shoes. These four shoes carry the requisite

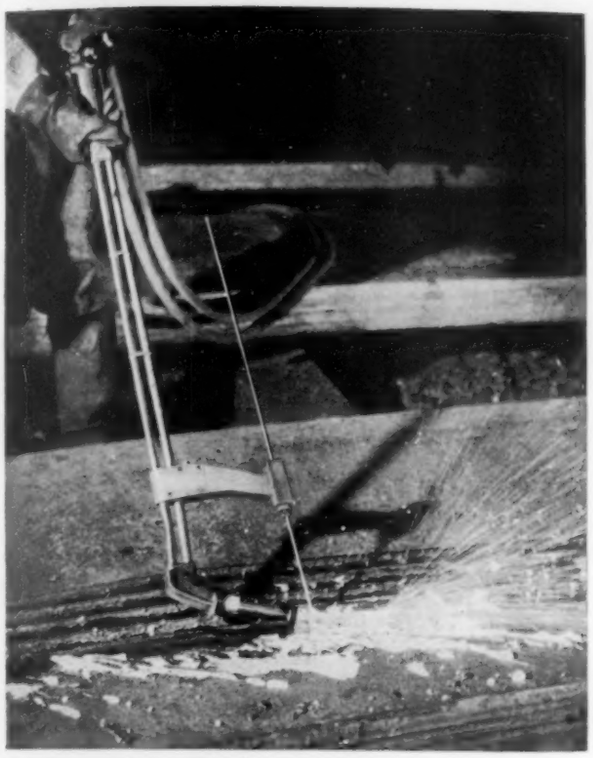


Fig. 5—Hand Scarfing

number of nozzles to give complete coverage to the four sides of the steel section being scarfed.

In the operation of the machine, the bloom passes between these banks of nozzles against the direction of gas flow, and in the passage the surface is removed to the predetermined depth. The bloom then passes out of the machine and on to subsequent rolling operations. Its entire original surface is removed in the form of molten metal and slag.

Flame Descaling

The flame-descaling process has proved particularly helpful in the removal of scale from steel castings and rolled or forged shapes and plates, including armor at certain stages. The process involves simply the fairly rapid passage of the high-temperature, high-velocity oxyacetylene flames over the scaled surfaces to be cleaned. The effect of this treatment is to heat rapidly the adherent scale to the point where its expansion is such as to cause it to loosen and pop off from the cool metal surface underneath. In some instances, this method of descaling has been found to be completely effective as an aid to subsequent machining.

In Fig. 7 the operator in the foreground is shown flame-descaling 8 by 10-in. blooms which are subsequently to be rolled into 5 by 5-in. billets for the production of blanks for shell forgings. The blooms are descaled on all four sides so as to reveal surface defects. This was formerly done by pickling, requiring several hours. The defects are then removed by hand-scarfing, this operation being performed by the operator shown in the background. During the last war defect removal was performed by chipping.

Flame descaling is used in a number of intermediate steps in making naval armor, particularly for the removal of furnace scale to facilitate layout and prolong tool life during machining.

Flame descaling is far superior to other methods for this work because it is rapid and requires little labor and little floor space. The quality of the results is also superior because none of the scale is peened into the metal as with other methods. Where the process is applicable it is faster and cheaper than pickling or bobbing, and competes with sand or shot blasting.

Many types of shells and gun forgings are also flame-descaled. On these parts the scale must be removed to permit machining. While specifications do not require it, some crankshaft forgings for naval use are also being flame-descaled.

Armor-Plate Cutting and Treating

The oxyacetylene cutting and softening of armor plate is now accepted for most specifications and thicknesses. Cutting procedures are similar to those commonly used for the plain carbon steels, the general difference being that high-speed nozzles giving a narrower heat-affected zone are used. As is true with most of the air-hardening steels, the armor-plate compositions respond to the flame-cutting process in such a way as to leave the cut surfaces in a hardened and unmachinable condition. This effect arises from the fact that the heat of the cutting reaction is sufficient to heat a thin layer of metal adjacent to the cut surface to a temperature above the critical, with a self-quenching of this heated layer to produce hardening.

Several methods of preventing or correcting the disturbance created by the flame-cutting action have been employed. The oldest of these, a procedure well known to those who have had occasion to cut high carbon and alloy steels, is preheating. Another method of eliminating the hardened zone created by flame cutting involves the reheating of the cut plate either as a part of a subsequent heat treatment or as a special tempering treatment to remove the objectionable hardness of the cut surface. This procedure is employed today at one mill in the cutting of combat tank armor in which the plates are cut to size before the final heat treatment prior to machining to finished dimensions.

A more popular treatment, which is both fast and economical and which is now in use on both Army and Navy plates, involves the reheating of the thin layer of affected metal adjacent to the cut surface by means of localized heat application. This procedure, known as

Fig. 6—Flame-Scarfing Machine in Blooming Mill

Fig. 7—Flame-Descaling (Foreground)

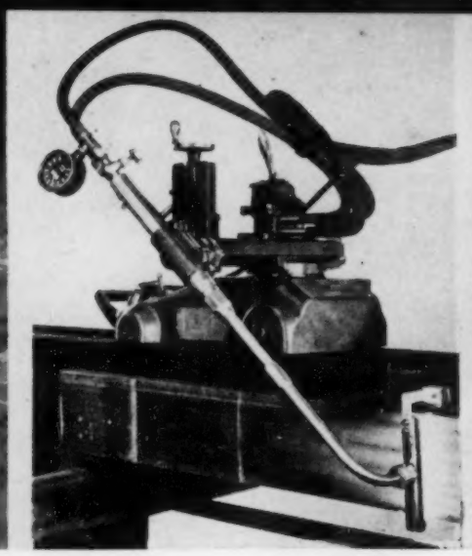


Fig. 8—Flame Softening

Fig. 9—Cutting Four Sprockets at One Ti

"flame-softening," is merely a tempering or drawing heat treatment which is restricted to the volume of metal which is hardened to an unacceptable degree. One accepted procedure provides for the passage of a row of closely spaced, high-velocity oxyacetylene flames across the flame-cut surface at a rate of speed sufficient to heat the hardened zone to a tempering temperature of about 1000° F. A close-up view of an oxyacetylene flame-softening head in operation is shown in Fig. 8. The effect of this treatment is to reduce the hardness of the cut edge materially and thereby to restore the toughness and requisite machinability. In employing this procedure it has been found that handling costs are low, no additional furnace capacity is involved and production is maintained at a high rate.

Shape-Cutting Tank Sprockets

Fabricating shops are finding oxyacetylene shape cutting indispensable in defense production. Not only is it possible to turn out work faster than by other methods, but also the process leaves presses, planers and other machines free for other needed work. Flame-cutting shapes steel rapidly and economically—in straight lines, circles or irregular shapes—while cut edges are clean and smooth, and require little or no machining. To further speed production, the trend has been toward multiple-blowpipe operation or the cutting of stacked plates.

A typical defense job is illustrated in Fig. 9. Here, drive sprockets for tanks are being cut four at a time. The four sprockets are cut simultaneously from the same templet in $1^1/_4$-in. steel plate requiring a one-hour production cycle. Two cuts are required for each sprocket —outside and inside.

The Welding of Aircraft Structures

The amount of attention that has been devoted recently to the construction of bombers and fighter aircraft might lead one to believe that the riveted aluminum, monocoque airplane construction had largely replaced oxyacetylene welded tubular structures. While it is true that transport planes, bombers and fighter craft are largely of the stressed-skin construction, many planes of

Fig. 10—Welding Tubular Aircraft Structure

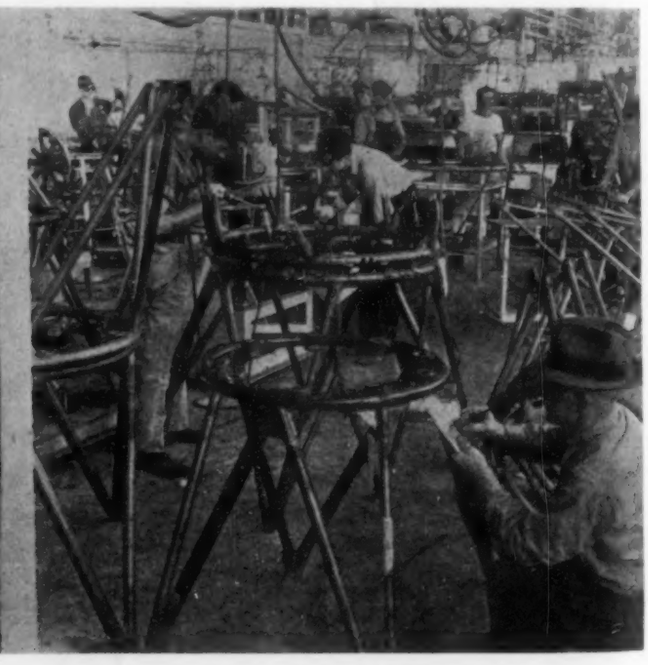


Fig. 11—Welding Motor Mount

Fig. 12—Welding Fuel Tanks

welded-tubing structure are still being made for use by the armed forces for training and scouting and also for use by civilians for private purposes. Welding such types of planes is illustrated in Fig. 10 where the operator is welding a cluster joint in a fuselage structure.

Also, it is often not realized that even the large, riveted aluminum planes have many parts that are fabricated from oxyacetylene welded tubing. Such parts as motor mounts, landing gears and innumerable brackets and other items are fabricated in this manner. Figure 11 shows the welding of motor mounts, including inspection by the man shown in the foreground. One design of an all-metal single-seater fighter plane has as many as 100 or more parts that are fabricated from oxyacetylene welded tubing. The larger planes, such as bomber and transports, frequently have many more.

Aside from the primary structure of aircraft, oxyacetylene welding finds wide application in the fabrication of fuel tanks and oil tanks that are made from sheet aluminum, as shown in Fig. 12, taken in the plant of a Canadian aircraft manufacturer. Also oxyacetylene welding is widely employed for the fabrication of stainless steel exhaust manifold collector rings and other sheet metal parts such as aluminum instrument panels and boxes, ammunition chutes, etc.

In connection with aircraft welding, it should be mentioned that oxyacetylene cutting is employed both in the shaping of steel parts for jigs and fixtures and in the shaping of certain structural parts. Oxyacetylene bronze welding, as well as fusion welding, provides a rapid and economical method for assembling jigs, and many aircraft manufacturers and subcontractors employ these procedures widely.

Mechanized Welding Developments

Finally, mention should be made of the role being played by oxyacetylene welding in defense production. Developments have been in the direction of the mechanization of the process in an effort both to simplify and to speed the joining of metal parts.

A typical mechanized application is the production of "Y" gun arbors which are part of the mechanism for ejecting depth bombs at sea. The parts to be welded are mounted in a jig which rotates at a constant speed. Four seven-flame heads heat the edges to be joined while the operator applies bronze welding rod through a rod guide. All operations, with the exception of the guided rod feed, are entirely automatic.

Arc Welding Relieves Cylinder Headaches*

CAST-IRON cylinder heads for huge 1500-hp. gasoline engines used by the Ohio Fuel Gas Company were a constant cause of trouble until a change-over was made to arc-welded steel heads. When these 24-in. cylinder heads became hot, they cracked. The cast-iron cylinder heads were repaired by arc welding, but after several breaks on the same heads it became necessary to junk them. Cost of these cast-iron cylinder heads to the fuel company was $250. Two heads are necessary for each cylinder of these four-cylinder engines.

Company engineers decided to replace the cast-iron cylinder heads with heads of arc-welded steel construction. This change-over was made eight years ago. Today, not a single cylinder head constructed from arc-welded steel has cracked or has required repairs. Total cost for the arc-welded cylinder head is $206.50—a savings in original costs of $43.50 plus the savings of hundreds of dollars from the alleviation of breakdowns and maintenance problems.

The cost of the arc-welded steel cylinder heads is itemized as follows: steel parts, $105.57; power, electrodes, helper, welder and overhead, $39.43; machining costs, $61.50.

* Mr. F. A. Jones, general foreman of the Ohio Fuel Gas Company, submitted this item to the Hobart Arc Welding News Contest.

Sabotaged Italian Ship Repaired

By A. F. Davis*

MAKING possible what is reported the speediest repair job of its kind ever performed, where speed was essential to restore much-needed cargo tonnage to service with minimum delay, the electric arc process of welding has again demonstrated its vital importance to National Defense.

This newest and perhaps most spectacular feat of the electric arc is the repair of the sabotaged engine of the S.S. *VILLAPEROSA*, interned Italian cargo vessel at the Atlantic Basin Iron Works, New York.

Repairs were completed in less than two months by arc welding, whereas to recondition the ship by installation of replacement parts would have taken at least a year. Welded repair thus saved ten months getting the vessel back into service to transport supplies which are vital in the International Emergency.

Damage to the engine, consisting of breakage of the bedplate into literally thousands of pieces, resulted when the huge crank arms, turned over by compressed air, jammed against heavy pieces of steel which were placed by saboteurs on the bedplate underneath the ponderous arms. The pieces of bedplate were said to resemble little more than the parts of a huge metal jig-saw puzzle when the repair crew started to work.

The principal damage, caused when the 19-in. diameter crankshaft jammed the huge arms onto the steel resting on the bedplate, was at the approximate center of the engine and in the middle of the frame.

Arc-welded repair consisted of fusing the many broken pieces of cast iron back together and joining reinforcing steel plates to steel dowel pins inserted in the bedplate.

First step of the work was the veeing out, or beveling, to 45 degrees of each broken piece of cast iron. This was followed by fitting the various pieces in place and tack welding (this consists of applying a small but sufficient amount of molten weld metal to adjacent parts to hold them firmly in position for the final, or continuous, welding). In quite a few instances it was found necessary to make pieces of steel to replace pieces of cast iron which could not be found. In such cases the pieces of steel were cut to a size and shape conforming to requirements.

Arc welding of the cast iron was done in accordance with standard procedure for electrodes, made expressly for work in cast iron.

Narrow beads—deposits of weld metal—never exceeding 3 in. in length were employed and the work was prevented from becoming too hot in order to avoid warping. Keeping the work cool by resting between welds, each bead, or weld, was lightly peened by hammer before proceeding with the next. In Fig. 1 can be seen some of the welds joining broken pieces of cast iron to the main structure of the bedplate, also the steel dowel pins holding the steel reinforcing plate in place.

Following the arc welding of all broken pieces of cast iron back into position, steel plates were fitted to the outside of the engine bedplate and holes drilled through the plates and the cast iron. Steel dowel pins of approximately 1-in. diameter were fitted into these holes and arc welded to the steel plate and to the cast iron. A special taper at each end of the pins allowed deep penetration of the weld metal into both the steel and the cast iron. Figures 2 and 3 show actual welding of the bedplate.

By its advantageous use on the *VILLAPEROSA*, electric arc welding which is being employed in all types of defense production because of the high speeds it permits in construction of ships, planes, tanks, guns, combat cars and other vital defense equipment, proved itself a fast-working tool for mechanical and structural repair needs.

Fig. 1—Arc Welds in Bedplate of Engine on Sabotaged Ship *VILLAPEROSA* Which Was Repaired in Less Than Two Months by Welding as Compared with at Least a Year to Obtain Replacement Parts

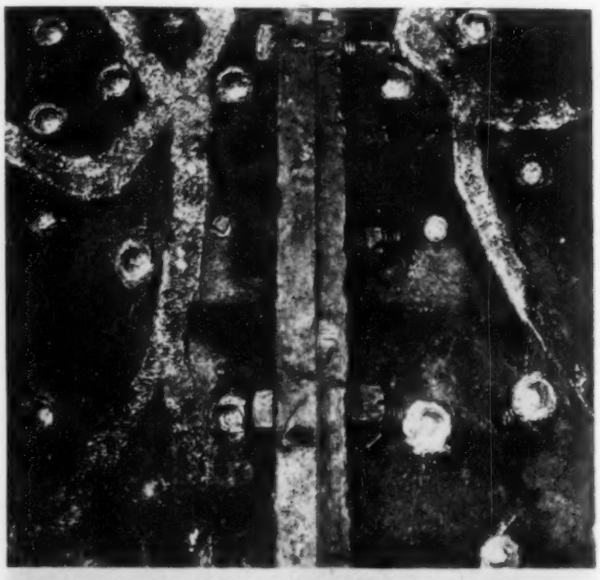
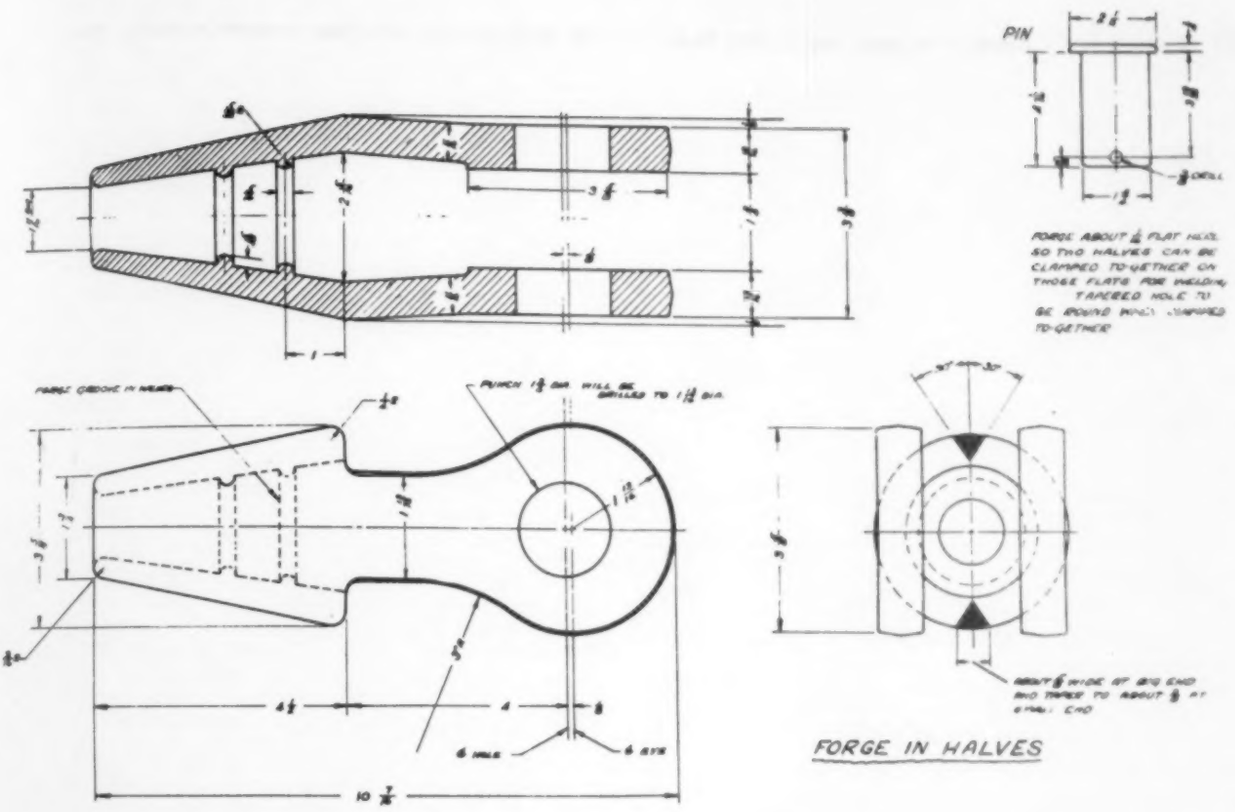


Fig. 2—The "Ship's Doctor" (Arc-Welding Operator) Operates on the Innards of the *VILLAPEROSA'S* Engine Repairing Injuries Resulting from the Work of Saboteurs

* Vice-President, The Lincoln Electric Company, Cleveland, Ohio.



Welded Socket

By Robert Wagner*

WHEN work began to lag in the weldery and machine shop of the Mississippi Valley Barge Line Company, Cincinnati, Ohio, a supplementary production of cable sockets for wire cable was inaugurated to "keep 'em rolling." In fact, even an improvement was made over all previous methods of construction.

Formerly, all sockets were forged into one piece. This method required an expensive die and involved a number of time-taking operations.

In the experimental stages, a $^3/_4$-in. plate was burned out to the proper shape, drawn out thin on one end in a simple form by a blacksmith, then heated and the cone formed in another simple shape. Two pieces, of course, were made exactly alike. Finally, these pieces were beveled and the two halves welded together. This new method permitted the forging of the two rings in the cone to prevent the zinc from backing out. Former methods of construction required machining of the solid cone for placement of the zinc.

The above method proved so successful that this company has decided to work a die for forging the halves for speedy production. Then the only remaining operations will be to weld the halves together, touch up the weld on the grinder and run a drill through the holes. This easy method of construction permits them to sell the sockets for 18 cents less than was necessary to be charged by the old method of construction.

* Hobart Brothers Co., Troy, Ohio.

Discussion Paper on Design of Welded Bridge*

L. S. Moisseiff, *Consulting Engineer:*

MR. HORTON'S design of a tubular compression member points in the direction of future development. If one may prophesy, tubular compression members will be eventually adopted in the design of structural aluminum. It is left to the future to develop suitable connections for them.

I would like to suggest that making the steel plate of the floor serve as a bottom chord for the truss will not work elastically.

Fred L. Plummer, *Chief Research Engineer, Hammond Iron Works:*

Mr. Horton's paper on the Design of a Welded Bridge is valuable in that it emphasizes the importance of new ideas and original designs rather than the mere modifying of designs now used for riveted fabrication.

With reference to the specific design suggested by Mr. Horton, I offer the following suggestions, listed in the

* Paper by George T. Horton published in the December 1941 issue of THE WELDING JOURNAL.

order in which the subjects were presented in Mr. Horton's paper.

1. Sections for Truss Members.—For the trusses of Cleveland's Main Avenue Bridge, box sections were used for large members and single rolled sections for smaller main members and all secondary members. Since I was partly responsible for this design it is apparent that I agree, in principle at least, with Mr. Horton. On this and many simiar structures access holes were provided in the box members so that they could be inspected and painted inside. Mr. Horton evidently does not believe these to be essential.

2. Form of Truss.—Mr. Horton suggests the use of a King Post Truss for the 150-ft. span used in his example. This is satisfactory; however, the use of a Queen Post Truss might result in the following advantages:

(*a*) 10% saving in truss material.
(*b*) Use of standard 24-in. pipe instead of larger fabricated tube.
(*c*) Length of sections suitable for economical shipping.
(*d*) More effective wind and vibration bracing.
(*e*) Better appearance by eliminating excessive height.

3. Tubular Members.—Based on the use of material, the tube is the most efficient compression member. Owing to the high unit cost of tubes commercially available, welded box sections made of plates and structural shapes of equivalent strength may cost less.

4. Floor Used as Lower Chord of Truss.—The floor is, of course, adequately strong for this purpose. Because of the size of the concentrated force coming from the upper chord of the truss and of its eccentricity, it would be difficult to design the "ears" to safely distribute this force to the floor.

5. Steel for the floor consisting of $^3/_8$-in. plate and bar trusses evidently weighs from 25 to 30 lb. per sq. ft. Steel for the floor consisting of $^1/_4$-in. plate with angle stiffeners and six inches of concrete weighs from 17 to 20 lb. per sq. ft. and the total floor weight would be about 90 lb. per sq. ft.

Several types of welded steel grid floors, filled with concrete, are now in common use. For instance, I-beam-lok $4^1/_4$ in. deep provides adequate strength to carry the specified loadings with a span of six feet or more. Steel weight is about 13 lb. per sq. ft. and total weight is about 55 lb. per sq. ft. Floor units are available in widths up to six feet and in lengths up to about fifty feet. These are welded in field to form single unit.

Open grid steel floors of welded construction are also available for locations where an open floor is not objectionable. These are, of course, quite light, and have been used on some long spans and on movable bridges.

Experience with concrete-filled steel grid floors indicates that the two materials act together.

6. For this size structure, a girder type of construction with floor, floor beams and girders welded into a single box beam unit might be used. Le Tourneau Company of Georgia has produced a grade elimination structure of this general type.

C. Earl Webb, *Division Engineer, American Bridge Company:*

Mr. Horton is proposing something entirely new, which is as it should be when it applies to a welded design for steel bridges. In the interests of economy, the old conventional details of riveted design should be discarded and new details of the welded design promoted instead.

The single strut at the top does not appear to be ample for stability, and I am not strongly in favor of the ear design to transmit the stresses of the bottom chord members. However, I agree with the conclusions in that there are commercial possibilities in welded bridge construction and I believe Mr. Horton is presenting ideas which will help to promote this type of construction.

Concluding remarks of Mr. George T. Horton:

These criticisms are largely directed to details, in which to quite an extent I concur, the principal point of my article being that if a bridge is to be welded, it must be designed quite differently than for riveted construction.

ANNUAL MEETING

Plans are under way for the next Annual Meeting to be held in Detroit during the week of October 12th.

All members who wish to present papers or who have suggestions for papers are urged to notify the Secretary of the Program Committee on or before March 30th, giving title and a sentence or two descriptive of what the paper will contain. These suggestions should be addressed to W. Spraragen, Secretary, Program Committee, American Welding Society, 33 West 39th Street, New York.

THE AMERICAN WELDING SOCIETY

ACTIVITIES — RELATED EVENTS

THE PRESIDENT'S MESSAGE

The present war program involves a great expansion of the welding industry. Some of this expansion takes place by enlargement of industrial plants incurring increased loads upon trained organizations. Much of the expansion, however, involves not only the building up of new plants but the recruitment and training of new organizations. Most of the personnel for these new plants will have had no previous experience in the production of war equipment. They will be furnished drawings and specifications and a considerable amount of detailed information as to the requirements of production.

It may be considered that such requirements are definite and that only one class of product can be fabricated if instructions are followed. A more careful analysis, however, indicates that this is not the case. The fabricating plants have many choices to make. They must provide facilities and equipment, but whether they will result in the proper quality of product depends upon an interpretation of drawings and specifications. No two men will interpret them in the same way, as the interpretation depends not only upon objective elements but also on the subjective elements of prior experience and training. In addition the plant executives have choices to make in selecting engineering personnel, workmen, materials and details of processing. Each of these involve judgment and affect cost and the final quality of the product.

The commercial production of war materiel is comparatively recent. It cannot be hoped that plans and specifications are going to anticipate every need of the service use of munitions. If our war products are to meet the requirements of their service use there must become imagination exercised by the production engineer and some visualization of the conditions of use under which materials, design and workmanship must stand up. Some of this materiel may be employed in subzero temperature, other under tropical conditions. Some may be subjected to sandstorms of the desert, others to the moisture of the tropics.

If this fabrication of materiel is to meet all of the requirements of our fighting forces our production engineers must visualize these problems and make decisions which will avoid the introduction of types of processing which may be fatal to use under some service conditions. Meeting the specifications may not be sufficient; meeting both specifications and service requirements should be the aim of our production engineers.

SCIENCE AND PRACTICE OF WELDING

The Science and Practice of Welding, by A. C. Davies, B.Sc. (London Hons, and Liverpool), A.M.I.E.E., Member of the Institute of Welding. 444 pages, 328 diagrams, illustrations and working drawings. Price $2.25. Published by The Cambridge University Press, The Macmillan Company, New York, Chicago, Boston, Atlanta, Dallas, San Francisco.

The aim of this book is to give, in a convenient form, the basic theoretical principles underlying the various processes of welding and the practical methods of applying them.

It should appeal equally to the practical welder requiring the correct technique for welding metals and alloys, and to the student welder requiring an understanding of the principles of physics, chemistry, metallurgy and electricity as applied to welding, no previous knowledge of these subjects being presupposed.

The book should prove useful to operators attending technical training classes.

A chapter on Engineering Drawing has been included, since most operators are called upon to read and understand a working drawing or blue-print.

The practical procedure given in the sections on electric arc and oxyacetylene welding has been carried out by the author during many years of welding and the training of operators, and the practical hints given should prove useful.

The Contents are as follows: Preface. Chap. I—Welding Science; Chemistry Applied to Welding; Fluxes; Heat; II—Metallurgy of Ferrous and Non-Ferrous Metals. III—The Practice of Oxy-acetylene Welding. IV—Electric Arc Welding (Theory and Practice). V—Gas Cutting of Iron and Steel. VI—The Inspection and Testing of Welds. VII—Additional Processes of Welding (Automatic Metallic Arc; Atomic Hydrogen Arc; Resistance; Seam; Upset Butt; Flash Butt; Thermit). VIII—Engineering Drawing. Appendix—Costing; Tables; Questions on Welding Science, Oxy-acetylene Welding, and Electric Arc Welding. Index.

FREE SILVER FOR RESEARCH AND DEVELOPMENT

Silver in a variety of forms has been made available without charge, on a consignment basis, to responsible manufacturers who are prepared to apply it intelligently in the solution of new research and development problems. Moreover, expert advice in the application of silver can be had for the asking through the American Silver Producers' Research Project in which most of the important American producers of silver are represented. This was made clear recently by representatives of Handy & Harman now in charge of the project.

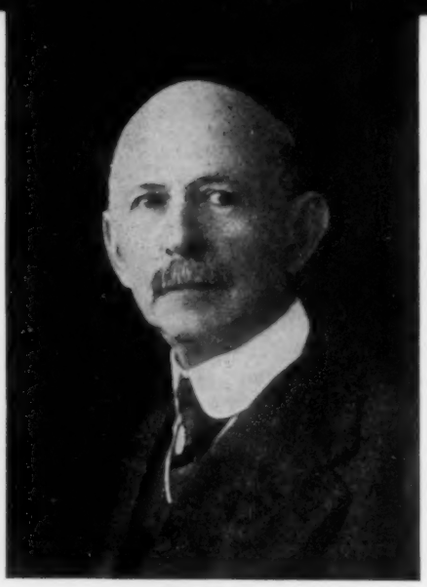
An objective, of course, is to find new industrial uses for silver. Such applications have been growing rapidly for a decade. Within this period, in fact, and quite independent of uses in silverware, industry has increased its consumption of silver to several million ounces annually. Several metals for which silver can be substituted are becoming scarce and cannot be had for non-defense applications. Silver is taking the place of these in some instances, especially where material costs are low in relation to total cost, but its primary industrial uses are based entirely on its merits and have no relation to the scarcity of other metals. A great fund of information concerning silver and its uses, much of it the result of extensive research, has been gathered by the project and is available to all interested manufacturers.

OBITUARY

Ezra Frick, president of Frick Company and the last of the great pioneers in the refrigeration industry, died at his home in Waynesboro, Pa., on February 2nd. He had been in failing health for more than a year. He passed peacefully away, just three weeks after his 86th birthday had been celebrated.

Ezra was the third son of George Frick (1826–1892), who in the middle of the century had established himself as a builder of steam engines. He entered the Frick Works as an apprentice in 1875, and thus began an uninterrupted term of active service with the firm which he continued for more than 65 years.

In 1880 the Company moved its operations to a big new plant on the west side of Waynesboro, and added Frick Corliss engines to its line of machinery. The reputation earned with its engine work resulted in a request in 1882 to transform an engine in Baltimore into a refrigerating machine. An ammonia cylinder was designed and put in place of the steam cylinder, while another engine was used as a drive. The next year a complete refrigerating machine, with two ammonia cylinders and a steam cylinder mounted between them, was built. In the following two years the vertical open type A-Frame Frick compressor, driven by a horizontal Corliss engine, was designed by Edgar Penny and A. O. Frick, whose engineering



Ezra Frick

skill was such that machines of this type remained the standard for the entire world for over 30 years.

By this time Ezra Frick had become foreman of the erecting department. He later became general clerk and then purchasing agent. In 1896 he became general manager of the Company, which office he held until 1928, part of the time being both general manager and treasurer. In 1924 Ezra Frick was elected president of the firm, which office he held as long as he lived.

As a pioneer in the refrigerating and ice-making industry, Mr. Frick was one of the founders of the Ice Machinery Builders' Association of the U. S. A., and became its secretary in 1908. He was president of the Refrigerating Machinery Association for the year 1919–20, and was elected an honorary member of that Association in 1936. He was one of the charter members of the American Society of Refrigerating Engineers, and was made its president for the year 1918. He was also a member of the American Institute of Refrigeration.

In 1885 Ezra Frick was married to Kate Mehaffey of Chambersburg, whose sister was the wife of A. O. Frick. Ezra Frick is survived by his daughter, Mrs. Frederica Wolf, a granddaughter, Margaret K. Wolf, and a sister, Mrs. Annie F. Good.

Mr. Frick was a man of great energy. He worked hard for long years with only the briefest holidays. He enjoyed excellent health, and maintained an aggressive frame of mind. Along with his intimate knowledge of manufacturing and business, he had an unusual foresight, and always insisted upon making improvements in the equipment, even far in advance of the times.

ALAN G. WIKOFF

Alan G. Wikoff, Editor-in-Chief of the General Publicity Department of Union Carbide and Carbon Corporation, New York, N. Y., died in White Plains, N. Y., on February 11th at the age of 46. His home was in Pleasantville, N. Y.

Mr. Wikoff was graduated from the College of the City of New York with the degree of Bachelor of Science in Chemistry in 1916 and received his Masters Degree in Chemical Engineering from Columbia University in 1917. During World War I he was connected with the Chemical Warfare Service for 2 years. After returning to civilian life he became associated with the McGraw-Hill Publishing Company, Inc., where for 6 years he served in an editorial capacity. For the last 17 years, he has been associated with Union Carbide and Carbon Corporation.

Mr. Wikoff was a member of The American Chemical Society, AMERICAN WELDING SOCIETY and International Acetylene Association, and has been particularly active on various committees of these societies.

WELDED BOOM

Necessity truly is the mother of invention. Pictured below is a welded boom and gathering head, built by two handy employees of the Snow Hill Co. of Terre Haute, Ind., for a huge coal-loading machine. Welded construction increased load capacity 10%—cut costs 50% over regular replacement expense. Construction time—four days.

Courtesy Hobart Brothers Co., Troy, Ohio.

National

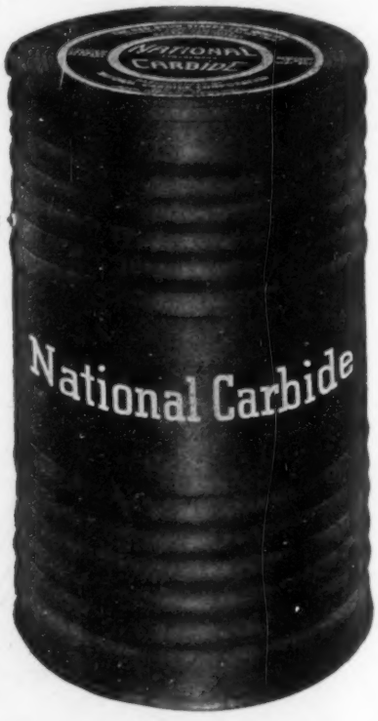
Carbide

IN THE RED DRUM

EFFICIENT

ECONOMICAL

DEPENDABLE



FOR WELDING and CUTTING

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60 E. 42nd St. NATIONAL CARBIDE CORPORATION New York, N. Y.

"We're *backing them up*"

Marching right along with the armed forces of this country are thousands of telephone workers.

They work side by side with the Army and Navy. Wherever the need is communications, you are likely to find telephone men and their trucks and materials.

Day and night the order is for speed and more speed.

They wear no uniforms, these telephone workers, but men in uniform know how much they are putting into the Nation's biggest job. They see it first-hand and they know it is first-rate.

BELL TELEPHONE SYSTEM

"THE TELEPHONE HOUR" IS BROADCAST EVERY MONDAY EVENING OVER THE N. B. C. RED NETWORK

J. W. SHEFFER PROMOTED

John W. Sheffer, associated with American Car and Foundry Company since 1908, has recently been appointed General Electrical Engineer of that Company.

J. W. Sheffer

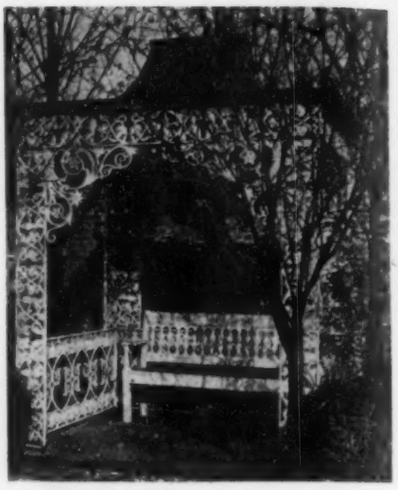
Mr. Sheffer graduated from Cornell University in 1907 with an M.E. degree and later in 1933 obtained his M.A. degree from Columbia University.

He began his association with A.C.F. in 1908 at the Berwick plant acting first as Electrical Engineer and later in the capacities of Assistant to the General Superintendent and Plant Engineer. During these 17 years he was engaged also with welding developments of all description, and was particularly responsible for the development of the Berwick Electric Rivet Heater.

In 1926, Mr. Sheffer was transferred to the New York office and since that time has been occupied with improvement and development problems in the several plants. Major welding installations have been made at 5 plants of A.C.F. and its affiliates.

Mr. Sheffer holds memberships in the American Institute of Electrical Engineers, AMERICAN WELDING SOCIETY, Iron and Steel Engineers and Cornwell Society of Engineers.

TEA HOUSE



Foresight and an arc welder made the attractive tea house, shown above, an enjoyable reality for W. H. Hobart, Vice-President of Hobart Brothers Company, Troy, Ohio. Constructed entirely from an old porch railing that was being junked by demolition crew hired by this arc welding company to clear ground for a new office building, this beautiful garden piece cost less than $25.

Original parts were cut into appropriate shapes with a welding torch and arc welded back together easily within a few hours' time. Pagoda roof was constructed from 18 gage steel arc welded together to form a sturdy roof with smooth seams. Iron work was set in a concrete center with brick edging. Construction and painting of entire tea house took eight hours' working time.

Since defense production has curtailed the production of ornamental iron work, here indeed is a worthy idea for the realization of your own tea house. Demolition work, especially near large defense projects is a very fruitful locale to find this iron work.

For SAFETY SPEED ECONOMY

REGO

MANIFOLDS
REGULATORS
VALVES and
FITTINGS

to control high pressure gases

The BASTIAN-BLESSING Co.
282 E. ONTARIO ST. CHICAGO

Pioneers and Manufacturers of Precision Equipment for Using and Controlling High Pressure Gases

ACRO WELDERS

of all conventional types are available for prompt delivery

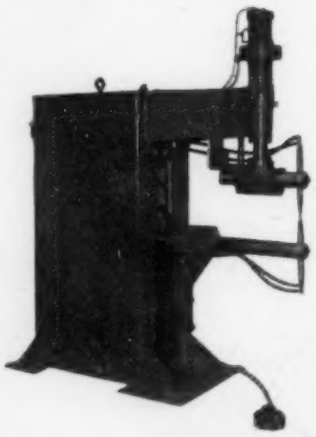


Illustration shows a heavy duty, deep throat, air operated, 100 kva. Spot Welder using hydraulic-controlled air cylinder, timing device, and accessories providing latest features of construction.

Foot, Air or Hydraulic-Operated, SPOT, PROJECTION, PULSATION, SEAM AND GUN WELDERS, 10 kva. upwards.

SPECIAL MACHINES FOR DEFENSE PROGRAM PRODUCTION

Send us your specifications.

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BUILDERS OF
BRAZERS—SPOT, PROJECTION, SEAM & SUN WELDING MACHINES

Welding Stainless?

★ Yes, far into the night—night after night—until the dawn of victory . . . they depend on **PAGE-ALLEGHENY STAINLESS STEEL ELECTRODES**—produced in close cooperation with the world's largest producer of Stainless Steel. That is possibly one of the reasons you can be certain that from **PAGE-ALLEGHENY** you can select the electrode that will give you deposit in the weld that equals the Stainless you are welding.

PAGE-ALLEGHENY STAINLESS STEEL ELECTRODES are shield-arc type; equally usable in horizontal and vertical positions; providing the exceptionally smooth beads that feature top quality welds.

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STAINLESS STEEL

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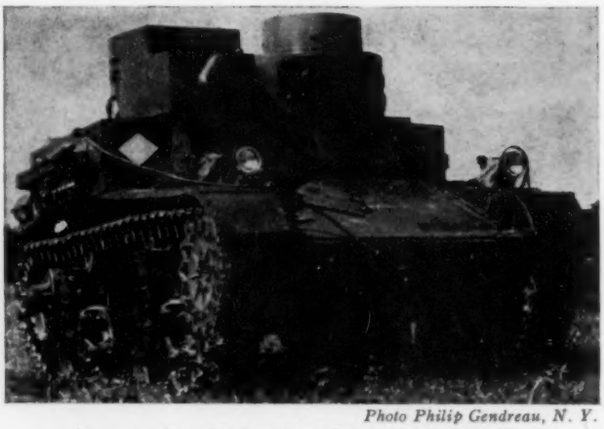

Photo Philip Gendreau, N. Y.

Army tank welded with stainless steel electrodes.

Foote

Pariflux - Calgran

(*Calcium Fluoride*) (*Calcium Carbonate*)

Flux - Essentials

1. **Graded particle size to materially reduce drying cracks.**

2. **Produced from selected raw materials to insure low reactivity with sodium silicate.**

FACTORIES—Wyndmoor, Pa.—Philadelphia, Pa.—Exton, Pa.

FOOTE MINERAL CO.

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Overlaying Drawing and Forming Dies with

Finishing Costs Cut 50-75%

For years, Ampco Metal has been noted for its outstanding success as a forming and drawing die material. Ampco Metal is the only bronze hard enough to serve satisfactorily in the forming and drawing of mild steel, stainless steel, and many other alloys.

Now, through the use of Ampco-Trode welded overlays on steel and cast iron dies, the nongalling characteristics which have heretofore been available only in full Ampco Metal dies can be obtained at low cost. Ampco Metal coated welding rod marketed under the trade name of Ampco-Trode is a rod that the performance-minded, economy-minded, progressive plant engineer cannot afford to overlook.

Other Important Uses

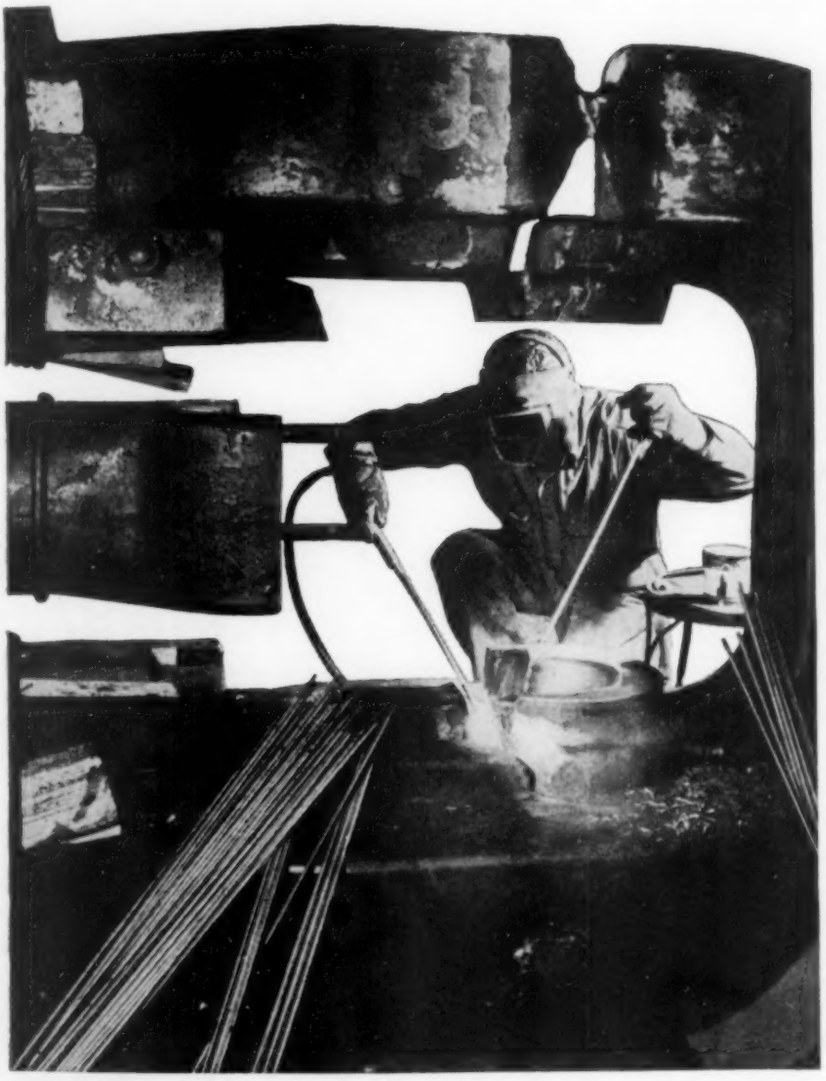
Made in six grades of hardness—from 100 to 375 Brinell—and rod sizes from $\frac{1}{8}''$ to $\frac{1}{2}''$, Ampco-Trode coated aluminum bronze welding rods have a long list of uses, such as welding on steel, cast iron, Ampco Metal, ordinary brass and bronze, nickel alloys and alloy steels. Suitable for building up worn shafts, wear strips and valve seats; also, for refacing to give extreme wear-resistance. You can use Ampco-Trode rods by all three methods—metallic arc, carbon arc and oxy-acetylene welding.

Ask for the new Ampco-Trode Bulletin which describes in detail application methods and welding technique. Illustrated with photographs and diagrams. Sent free on request.

AMPCO METAL, INC.

Dept. WJ-3 Milwaukee, Wis.

BRONZE WELDING SCORES ANOTHER PRODUCTION VICTORY



*Anaconda 997 (Low Fuming) Welding Rod, *Tobin Bronze and other Anaconda Copper Alloy Welding Rods are always "on call" for vital war work.

400 pounds of Anaconda 997 (Low Fuming) Welding Rod make this crippled press fit for work in 119 man hours

☆ ☆ ☆

A huge press like this one, if disabled, ordinarily requires months to duplicate. So when this one broke down while turning out urgently needed war material, a tense situation resulted.

However, the resourceful Hebeler Welding Company, Buffalo, New York, provided the way to give our war program the use of this press with a minimum delay... repair welding with Anaconda 997 (Low Fuming) Rod.

400 pounds of this bronze welding rod were used, 3100 cubic feet of air and gas were consumed and 119 man hours required for the chipping and welding which restored this press to active service.

*The trade-marks "Anaconda" and "Tobin Bronze" are registered in the U. S. Patent Office.

4200

ANACONDA from mine to consumer

Anaconda Welding Rods

THE AMERICAN BRASS COMPANY—GENERAL OFFICES: WATERBURY, CONNECTICUT

In Canada: ANACONDA AMERICAN BRASS LTD., New Toronto, Ontario • *Subsidiary of Anaconda Copper Mining Company*

STRENGTHENING ROAD-BUILDING MACHINERY

In order to obtain the rigid construction necessary in road-building equipment, the Gledhill Road Machinery Company, Galion, Ohio, uses arc welding for fastening reinforcements to the chassis of road shapers, road adjusters and other road-making machinery.

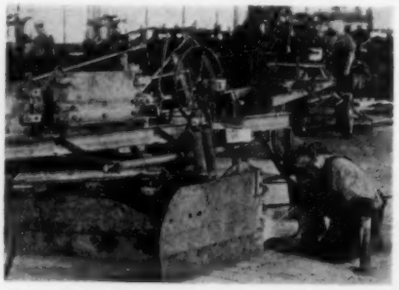
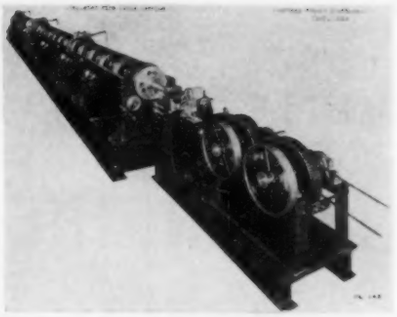


Photo courtesy General Electric Co.

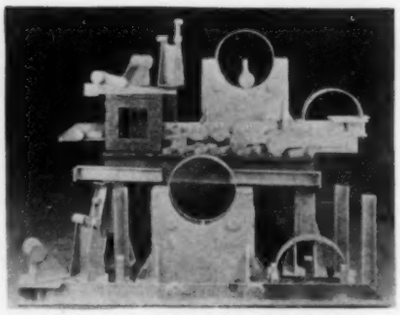
According to William Gledhill, chief mechanical engineer of the Gledhill Company, arc welding is the only satisfactory method of doing this job, as other types of construction tend to loosen under the hard usage to which the road builders are subjected. It is also reported that arc welding is currently saving 25% in production costs.

WEAVING MACHINE

Photographs above show a special wire cable weaving machine of all welded steel construction built by W. A. Hudson Boiler & Welding Co. of Chicago. (Lower) Frame parts of standard steel shapes, flats and bars were flame cut to shape. Center drum was constructed from extra heavy seamless steel pipe for maximum strength. Finished machine was approximately 40 ft. long, 3 ft. high and 30 in. wide. Weight 8000 lb. Weight savings over similar cast-iron machine was 3990 lb.



Completed Wire Cable Machine



Photos courtesy Hobart Brothers Co., Troy, Ohio.

Frame Parts for All-Welded Wire Cable Machine

PORTLAND OXYGEN COMPANY

The Portland Oxygen Co. is constructing a new modern oxygen plant. This company is a direct branch of the Seattle Oxygen Company, which is the oldest independent oxygen company this side of Minneapolis, having been engaged in the manufacture and distribution of oxygen, acetylene and welding apparatus continuously for the past thirty years. The new plant under construction will be all reinforced concrete and steel and of modernistic design and will be equipped with the latest in oxygen manufacturing equipment.

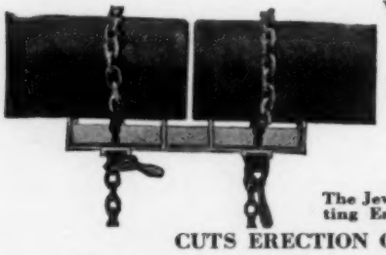
EUTECTIC ALLOYS

Mr. J. C. Gowing of 1007 Santa Fe Avenue, Los Angeles, Calif., will, in addition to acting as distributor for Hobart Arc Welders, handle the Castolin Eutectic Alloys for Eutectic Welding Alloys, Inc.

NEW CUTTING TIP

Airco "45," an 8-page illustrated booklet just issued by Air Reduction Sales Co., New York, describes this new high-speed

PIPE WELDING TOOLS THAT MAKE WELDING PAY



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TWO SIZES
½ to 8 in. 8 to 16 in.
Light—Adjustable—Fast

The Jewel System of Pipe and Fitting Erection Ready for the Weld

CUTS ERECTION COSTS

Keeps the Welder Welding Instead of Waiting

JEWEL MANUFACTURING COMPANY
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Buy "Proven Fluxes" with Years of Guaranteed Satisfaction behind them
The Trade-Name is "ANTI-BORAX"

Ask for Them ***Unequalled for Quality***

A Flux for every metal: Cast Iron Welding Flux No. 1; Brazing Flux No. 2; Braz-Cast Flux No. 4, for bronze-welding cast iron; "ABC" Aluminum Flux No. 8 for sheet Aluminum and all alloys of Aluminum; Stainless Steel Flux No. 9; Silver Solder Brazing Flux No. 10; "Anti-Borax" Tinning Compound No. 11.

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MALLORY STANDARDIZED WELDING ELECTRODES

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LESS DOWN TIME
BETTER WELDING
LOWER COST

The men who man high speed spot welding guns, single and multiple spot welders, seam welders and flash welders . . . rely on Mallory for long life electrodes! Write for your free copy of the factual Mallory Resistance Welding Data Book . . . today.

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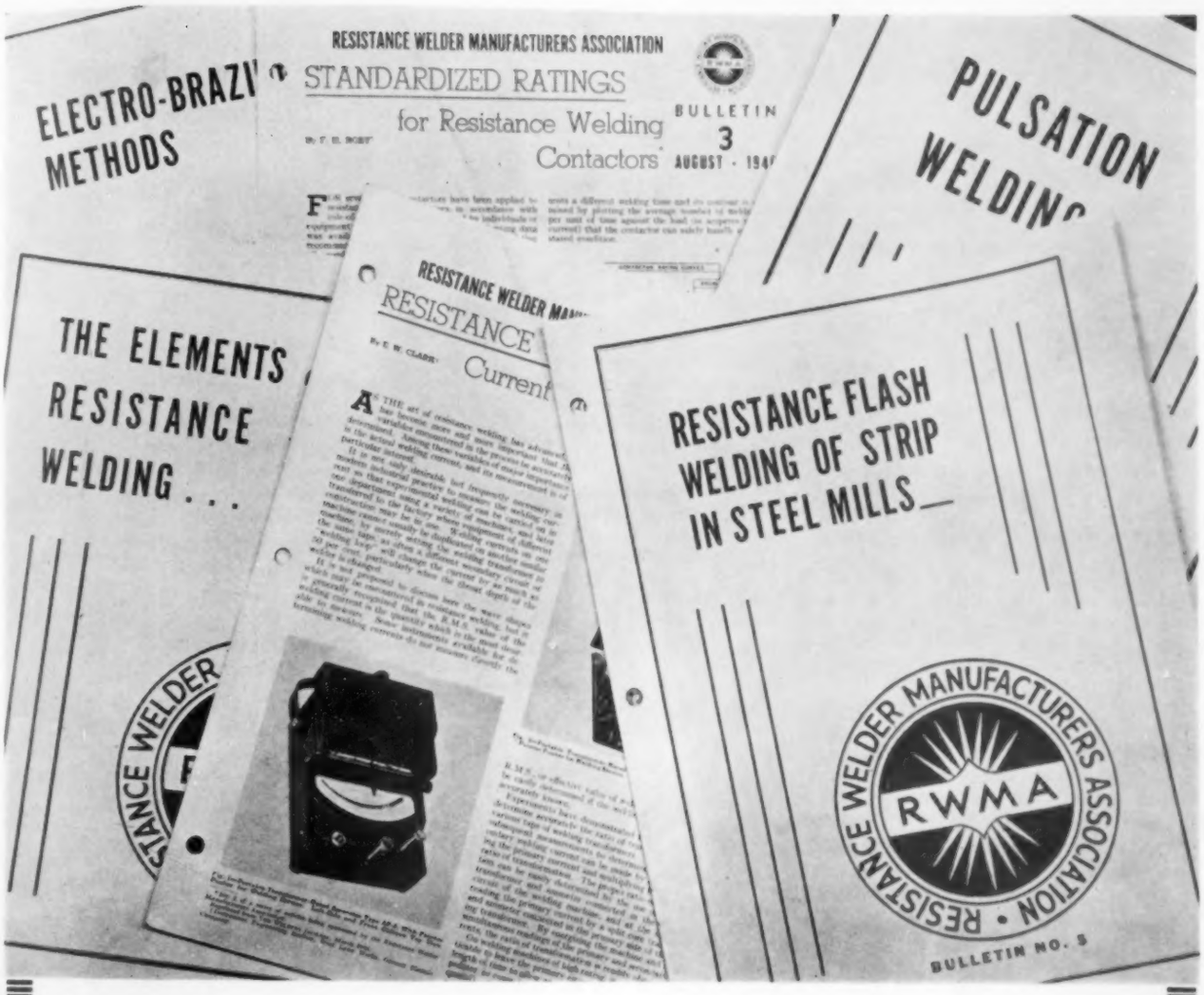

TECHNICAL LITERATURE ON RESISTANCE WELDING—

The Resistance Welder Manufacturers' Association publishes from time to time technical articles or reprints on resistance welding subjects of general interest. The Association invites anyone interested in the development of resistance welding operations to write in for these bulletins. Complete information on request.

RESISTANCE WELDER MANUFACTURERS' ASSOCIATION

505 ARCH STREET PHILADELPHIA, PA.

MEMBER COMPANIES

Eisler Engineering Company, Newark, N. J.
Expert Welding Machine Company, Detroit, Mich.
Federal Machine and Welder Company, Warren, Ohio
Multi-Hydromatic Welding and Manufacturing Co., Detroit, Mich.
National Electric Welding Machines Co., Bay City, Mich.
Progressive Welder Company, Detroit, Mich.
Swift Electric Welder Company, Detroit, Mich.
Taylor-Hall Welding Corporation, Worcester, Mass.
Taylor-Winfield Corporation, Warren, Ohio
Thomson-Gibb Electric Welding Co., Lynn, Mass.
Welding Machines Mfg. Company, Detroit, Mich.
Acme Electric Welder Company, Los Angeles, Calif.

ASSOCIATE MEMBER COMPANIES

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Electroloy, Inc., New York, N. Y.
Welding Sales and Engineering Co., Detroit, Mich.
P. R. Mallory and Co., Indianapolis, Ind.

machine cutting tip which increases the speed of flame cutting 20 to 30%.

The booklet contains a complete pictorial presentation of the "45"—an outstanding addition to Airco's line. It explains clearly the revolutionary design features. Performance facts and figures are described in text and chart form. A table of specifications enables buyers to tell at a glance the proper tip for their particular needs.

Copies of this booklet, ADC-631, can be obtained by writing Air Reduction Sales Company, 60 East 42nd Street, New York, N. Y.

INDUSTRIAL DEFENSE LEADERS VIEW SPEED-UP TRAINING FILM

Industrial training for defense was the chief subject of discussion at the testimonial dinner for James F. Lincoln, president of the Lincoln Electric Company of Cleveland, at the Biltmore Hotel, Los Angeles, on Monday evening, Jan. 26th. More than a hundred leaders in the industrial defense program in this area, representatives of government production agencies and army-navy officers turned out to pay tribute to the nationally known industrialist.

The main feature of the program was the première screening of one of the first motion pictures designed to speed up defense training for industry, and increase the country's pool of skilled man-power.

This picture, "Inside of Arc Welding," produced by Raphael G. Wolff of Hollywood, is an all-color instruction film illustrating the technique of arc control and electrode manipulation and showing the various steps in the welding process. It marks the first step in the application of visual education methods to welding instruction.

PRODUCTION SPOT WELDING

An excellent example of how resistance spot-welding technique may be employed in manufacturing—even where the character of material to be welded may change materially—is to be found in the setup for producing refrigerator evaporators at Sunbeam Electric Manufacturing Company.

Sunbeam, large producer of such units for a well-known organization selling through both mail-order and retail outlets, employs a total of 7 spot welders and 2 seam welders to produce the entire range of evaporator units for all sizes of household refrigerators (see Fig. 1).

Furthermore, it makes no difference as far as the welding equipment is concerned whether these units are to be fabricated from stainless steel, enamel iron or in-between alloys. A variation in the type of material to be welded merely involves setting of a dial on the control on each machine and transformer heat-selector switch to produce the correct welding characteristics for that material.

Photo courtesy Progressive Welder Co.

Fig. 1—Part of the Spot-Welding Setup at Sunbeam for Fabrication of Refrigerator Evaporators. At Left and Right Are the Multi-Spot Welders, While in the Background Are the Pedestal Welders for Welding of Baffles and Center Rows of Spots

This is proving particularly important at the present time in view of difficulties in obtaining stainless for non-defense production requirements.

OKLAHOMA ENGINEER DESCRIBES WELDING SOCIETY

The Society is indebted to Mr. K. B. Banks, Chairman of the Program Committee of the Oklahoma City Section, for a comprehensive description of the work of the Society published in a current issue of *The Oklahoma Engineer*.

You'll do it better with

SHAWINIGAN CARBIDE

SHAWINIGAN PRODUCTS CORPORATION
EMPIRE STATE BLDG., NEW YORK

SAVE MONEY . . . BY WELDING

Jaw Plates, Gyratory and Roll Crushers, Shovel Teeth, Hammers, Tractor Tread Grousers
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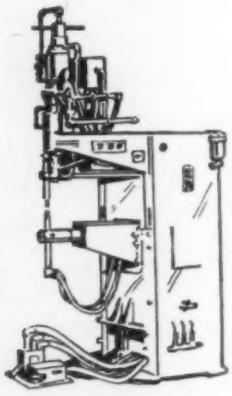
MANGANAL

Reg. U. S. Pat. Office. U. S. Patents 1,876,738—1,947,167—2,021,945
11 to 13% Manganese Nickel Steel
WELDING ELECTRODES, WEDGE and APPLICATOR BARS, HOT ROLLED PLATES

STULZ-SICKELS CO. *Sole Producers* 134-142 Lafayette St., Newark, N. J.
Sold Through Distributors Only

CLEAN BEFORE WELDING



and Get Better, Stronger, More Uniform Welds With Fewer Rejects

Whether you are spot welding aluminum or welding other metals, experience shows that a clean surface . . . free from all grease, dirt or other foreign matter . . . makes possible a better, stronger weld. And since results are more uniform, rejects are lower. But PLAY SAFE! Do your cleaning the fast, thorough, low-cost Oakite way, with materials that have been specially designed and APPROVED for this work. Money-saving details FREE on request. Write today.

OAKITE PRODUCTS, INC., 18E Thames Street, NEW YORK, N. Y.
Representatives in All Principal Cities of the United States and Canada

OAKITE Specialized **CLEANING**

SHORT-SHORT STORY ON "FP"
—versatile, new, high-speed electrode.
POSITIONS: Horizontal fillet, vertical, overhead and downhand welding.
TYPES OF WORK: Low or medium carbon steel fabrication; especially good for loose fit-ups.
COATING: Tough, non-absorbent coating permits reasonable bending without cracking.
DIAMETERS: Standard from 3/32" to 3/8".
LENGTHS: All diameters in 14" length; four largest also in 18" length.
MEETS CODE REQUIREMENTS of A.W.S. and A.S.T.M. Tentative Electrode Specifications for Classifications E6012 and E6013. Also A.S.M.E. Boiler Code paragraph U69. Approved by American Bureau Shipping for Hull, Class 1 and Boiler, Class 1, all positions.

Get acquainted with F.P.

. . . SAY GOOD-BYE TO A LOT OF COMMON WELDING TROUBLES!

Here's an electrode that's NEWS—NEWS because it makes available for the first time an electrode developed especially for your own precision manufacturing operations—NEWS, because it gives a new type of all-round welding performance.

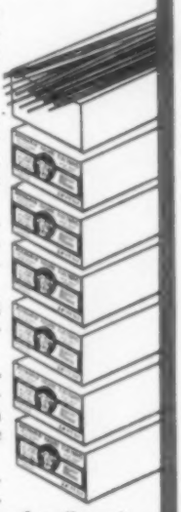
Designed especially for horizontal fillet welding, the new Westinghouse **FLEXARC FP** electrode can be used equally well for vertical, overhead or downhand welding.

FP cuts costs by reducing excessive spatter loss, especially at high current rates. **FP** works equally well with either a-c or d-c. Crater blisters and slag pits are reduced—even the first pass with an **FP** rod lays down flat and smooth.

Free Electrode Wall Chart

Check the characteristics of this and other new Westinghouse electrodes. Ask for **FREE** copy of the Westinghouse Electrode Chart. It makes ordering easy—and contains some mighty useful information for the man on the job. Ask for WC-426.

Handy Westinghouse "Shopping List" for Electrode Buyers



FlexArc FP—For fillet position and general purpose high-speed welding on low-to-medium carbon steels. A-c or d-c.

FlexArc DH—For heavy, high-speed, flat or horizontal fillet welding on low-to-medium carbon steels. A-c or d-c.

FlexArc AP—For all position welding on low-to-medium carbon steels. Reverse polarity d-c.

FlexArc SW—For general purpose, all position welding. A-c or d-c.

Castingweld and Freemachineweld—For welding any type of iron casting. Latter type can be machined.

Hardentough—For hard-surfacing parts of machinery and equipment. Grades for all needs.

FOR SPECIAL APPLICATIONS—*Nickelchromeight, Nickelchromtwelve, Nickelmang, Bronzark.*

J-21166

Westinghouse

FLEXARC ELECTRODES

IRON MEN AND THEIR DOGS

An unusually interesting historical document appears under the above title and is a presentation of the development of the Bartlett Hayward Division of the Koppers Company.

The Bartlett and Hayward traditions reach back for over a century, during which the firm has been the foremost pioneer in many notable engineering developments, and especially in the manufacture of domestic gas plants. It has three times participated in the defense of our country.

This story of the progress of *Iron Men and Their Dogs* portrays the growth of "Bartlett-Hayward" from cook stoves to massive reclamation project castings, from cast iron to an epoch-making high-tensile bronze, from domestic water heating boilers to gigantic modern gas holders and, as Baltimore auctioneers comprehensively declare, "other genuine articles too numerous to mention." All its progress has been under the talisman of two cast-iron replicas of the primogenitors of the Chesapeake Bay Dog.

ALL-WELDED OVERHEAD FACILITATES MATERIAL FLOW

When increased defense program activities recently required an expansion of a division of the Harnischfeger Corporation into an adjoining building, welding came to the rescue in a rather unusual manner. Since conveyance of material to and from

the buildings on ground level would tie up an important plant thoroughfare, an overhead bridge was designed.

All welded in construction, its erection progressed rapidly. Completed, it has a concrete floor and is fully enclosed, with large window areas providing ample daylighting. In the above scene a new model P & H welder is shown speeding the work.

WAR PRODUCTION BOARD

An interpretation of the preference rating order granting priority assistance to research laboratories has been issued recently in order to make clear that the preference rating assigned cannot be used for construction or expansion of laboratory buildings.

The exact wording of Interpretation No. 1, Preference Rating Order P-43 is given below.

OFFICE OF PRODUCTION MANAGEMENT

PRIORITIES DIVISION

RESEARCH LABORATORIES SUPPLIES AND EQUIPMENT

INTERPRETATION NO. 1 OF PREFERENCE RATING ORDER NO. P-43

The following official interpretation is hereby issued by the Director of Priorities with respect to Preference Rating Order No. P-43, dated August 28, 1941.

The preference rating assigned by said Order may not be applied to obtain material to be used in the construction of laboratory buildings or other structures The only material which may be obtained under the Order by a laboratory is that which will itself be used in the conduct of scientific research or which will enter into the production of material which will be so used.

Issued this 23rd day of January 1942.

MODIFIED PRODUCTION REQUIREMENTS PLAN

The small *manufacturers* in the SOCIETY may be vitally interested in a new plan just announced to give them relief in securing raw materials. Here are the essential features:

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"Today's "all-out" demands that waste of vital materials, time and man-power stop. We need every bit of all three to produce more planes . . . tanks . . . and ships."
Save Up to 30% in GAS..TIME..LABOR on production welding—
INSTALL REGO automatic GAS ECONOMIZERS at all of your welding stations
Want full details?
Request copy of Form NR-112—it gives complete specifications on the construction and operation of RegO economizers.
How much will you save?
Try a RegO economizer at one of your welding stations for several days and you'll have the exact answer.
RegO automatic GAS ECONOMIZER for production welding..brazing..soldering
REGO . . . pioneer equipment for using and controlling high pressure gases . . . distributed by
NATIONAL CYLINDER GAS COMPANY
205 W. Wacker Drive
Chicago, Illinois
Offices in Principal Cities

1. Any manufacturer whose annual volume was less than $100,000 in 1941 whether or not he is engaged in war production may make application for priorities assistance.

2. Consideration will be given to (*a*) the importance of the product to the war program *or* the national welfare; and (*b*) the fact that the release of a small quantity of scarce materials may help maintain employment or free available materials now tied up.

3. The applicant must fill out a form (PD-25-X) on which priorities assistance will be requested for the purchase of scarce materials as specified by the War Production Board (Materials List No. 2).

4. Forms and complete instructions can be secured from the Small Business Section of the Production Requirements Branch, War Production Board, Washington, D. C., or from the branch office of the War Production Board located nearest to the applicant.

WELDING NEWS

An arc welding news magazine "Hobart Arc Welding News" is now being published by Hobart Brothers Co., Troy, Ohio. This interesting publication will be sent free of charge to anyone writing the company's Direct Mail department and asking to be placed on the regular magazine mailing list. Editorial matter is made up from entries in the Hobart Arc-Welding News Contest; letters to the editor; and articles by welding experts.

ENGINEERS FOR THE WAR PROGRAM

The Civil Service Comission, recruiting for the Federal civil service, is accepting applications for all grades and branches of engineering. Engineer examinations, some recently consolidated and modified, are listed below. None require a written test. For the Junior grades, $2000 a year, applicants are rated on their engineering education; no experience is required.

Junior engineer, aeronautical, naval architecture and marine engineering, Announcement 122. The usual college engineering course must include work in the optional branch chosen unless the applicant has taken an appropriate defense training course, or has had prescribed experience in the branch chosen. Age limit —40 years.

Junior engineer, all other branches of engineering, Announcement 172. A new feature is that certain college courses (other than the usual engineering courses) may also be accepted if supplemented by appropriate engineering defense training courses. Previous Announcement 51 admitted senior college students who will complete prescribed courses by June 30, 1942. The new examination also admits those who will complete such courses by June 30, 1943. Age limit—35 years.

In the upper grades, applicants are rated on education, experience and record of accomplishments. In all but the chemical engineer examination, professional engineering experience may be substituted for the college work.

Naval architect, Announcement 98; marine engineer, Announcement 99; $2600 to $5600 a year.

Engineer (all other branches), $2600 to $5600 a year, Announcement 173. Especially needed, particularly in the associate and assistant grades, are engineers experienced in the following fields: Aeronautical, Electrical, Radio, Telephone, Mechanical (particularly machine design and development), Heating and Ventilating, Industrial, Sanitary, Hydroelectric, Irrigation, Construction-Estimating, Structural, Explosives, Plumbing, Public Health, Welding, Hydraulic.

There are also opportunities in the subprofessional and lower grades.

Technical assistant (engineering) $1800 a year, Announcement 177. Three years of a 4-year college course must be shown including work in mathematics, physics, and allied engineering subjects. Appropriate engineering defense training courses will satisfy a part of the requirements. The age limit is 53 years.

Engineering draftsman, junior to chief grades, $1440 to $2600 a year, Announcement 174. This examination supersedes a number of others and includes 20 different optional branches. Engineering education is one of the alternative or substituted requirements. Age limit—55 years.

AIRCRAFT WELDING

Aircraft Welding, by L. S. Elzea, Supervisor of Welding, Division of Aircraft Training, Public Schools, Wichita, Kansas. This book is recommended for high-school welding courses, night-school classes, vocational schools, commercial aircraft schools and, in fact, any place where aircraft welding is taught. It can be used also as a guide by men who wish to practice at home or in the shop.

The use of highly technical terms has been avoided as much as possible and those that have been used have been explained thoroughly. Pictures of actual welds are presented in the text to give the correct idea of the appearance of good welds.

The specifications and explanation of the official army test, with pictures and drawings to illustrate certain points, are included in the book. Published by McGraw-Hill Book Co., New York, N. Y. Price $2.00.

HEATING AND VENTILATING GUIDE

The 1942 edition of Heating, Ventilating, Air Conditioning Guide marks the Twentieth Anniversary of publication. In 1922 the first issue of The Guide was a book of only 360 pages, limited in its coverage of the technical phases of the industry and in presentation of manufacturers' equipment data. The 1942 edition contains 1256 pages and treats exhaustively every phase of heating, ventilating and air conditioning, and related phases of refrigeration. This book is published by the American Society of Heating & Ventilating Engineers, 51 Madison Avenue, New York, N. Y.

During the 20 years of publication, many men of long training and expert knowledge of their respective fields have contributed engineering data and general information that have made the Technical Data Section the accepted authority in every branch of the profession and the industry. The Guide is now widely used as a reference book in America and abroad; in many schools and colleges it is used as a text and reference book.

This year The Guide is bound in a stiff blue cover with gold stamping and individual copies can be obtained at $5.00 a copy. A thumb-indexed edition is available with chapter tabs at $5.50 per copy for those who desire this particular feature.

STRUCTURAL WELDING SAVES 20% OF STEEL

The use of arc welding for fabricating the steel framework of a factory building and an office building recently constructed for the California Cold-Rolled Steel Corporation, Los Angeles, helped to save 20% of the steel which would have been required had the frames been of riveted construction.

Photo courtesy of G. E. Co.

Frame of the Factory Building (Interior)

Two interesting innovations are reported in regard to design and construction of these buildings. First, instead of the usual column construction, the columns of the buildings were made up of three "I" beams arranged to form an "H" section. The beams forming the flanges were smaller than those forming the central web. The beams were held together over their entire length by arc-welded seams of the intermittent type.

The other unusual but highly successful feature of this building was the use of alternating-current arc welders for field assembly work. Although it is common practice to use a-c welding for shop fabrication as was done in this case, d-c welders have ordinarily been used for field welding.

Both field and shop fabrication was done by the Steel-Weld Building Corporation of Los Angeles. The new factory building, 55 ft. wide and 250 ft. long, with sides of sheet steel, will house a cold-rolling mill for handling narrow strip work.

HOW TO WELD Y'S FOR WAR PRODUCTION

Built to resist refinery corrosion, these are lined with Monel, using No. 130-X Monel Welding Electrode

20" O.D. x 16" O.D., 16 ga. Monel-lined, steel Y reducers for rundown lines on petroleum fractionating towers. The top sections of which are also lined with Monel.

Photo courtesy of Robinson Engineering Co., Garwood, N. J.

Now, more than ever, it is important for welders to know how to handle Monel. Thousands of pounds of this useful alloy are going into our all-out effort for Victory . . . into the Petroleum Industry, for example:

Because Monel stands up against corrosive conditions in the refining of high octane gasoline, lube oils, toluol and other petroleum products, it is widely employed in refineries to protect equipment, reduce maintenance and shutdowns. A typical application are the Y reducers shown. Part of the rundown lines for a fractionating tower, they are made of steel, and lined with Monel sheet, using *No. 130-X Monel Welding Electrode.*

Note in the table (right) the types of Welding Rods recommended for different jobs. Write for full information and working instructions on the welding of Monel, Nickel and INCO Nickel Alloys. Address:

INCO WELDING MATERIALS

MONEL

Oxy-Acetylene . . . No. 40 Monel Gas Welding Wire — Monel Gas Welding Flux.

Metal Arc . . . No. 130-X Monel Welding Electrode.

NICKEL

Oxy-Acetylene . . . No. 41 Nickel Gas Welding Wire — no flux is used.

Metal Arc . . . No. 131 Nickel Welding Electrode.

INCONEL

Oxy-Acetylene . . . No. 42 Inconel Gas Welding Wire — Inconel Gas Welding Flux.

Metal Arc . . . No. 132 Inconel Welding Electrode.

NICKEL-CLAD STEEL PLATE

Metal Arc . . . No. 131 Nickel Welding Electrode.

FIRST THINGS FIRST—With the Nation at war, supplies of Monel, Nickel and Nickel Alloys are needed for our armed forces. Although all efforts must now be aimed toward victory, The International Nickel Company will continue to report information of value to metal users who are concerned with the war efforts of today and the peace-time progress of the future.

"Monel" is a registered trade-mark of The International Nickel Company, Inc., which is applied to a nickel alloy containing approximately two-thirds nickel and one-third copper.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK, N. Y.

NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this Section

DIVERGENT NOZZLE TIPS

A series of oxyacetylene machine cutting tips of revolutionary design increase the cutting speed of machine torches by 20 to 30% and assure cuts of a quality comparable to those obtained with standard tips. They represent a particularly important and timely development because of the increased speed in war production that they will make possible. The tips have been developed by Air Reduction, 60 E. 42nd St., New York, N. Y.

The Airco "45" high-speed machine cutting tip has a nozzle with a divergent exit portion—a design that makes it possible to eject a narrow, high velocity stream of oxygen, practically free of exit turbulence, that burns a narrower path or kerf, through the metal, than the conventional cutting tip. As a result of burning away less width of metal in a cut, the Airco "45" cuts with no increase in oxygen consumption.

To obtain a kerf of narrower width than that obtained in standard cutting practice, it is necessary to use a narrow, parallel-walled oxygen stream. This is obtained when a high operating pressure is used in a divergent tip that reduces the exit turbulence of the oxygen stream. The Airco "45" divergent tip, developed after intensive research, is practically free from turbulence.

As the oxygen stream penetrates steel, its velocity is constantly dissipated. The divergent tip principle increases the velocity of the oxygen stream and provides a higher oxygen concentration at greater depths, thereby increasing the oxidation rate of the metal being cut. This makes cutting with Airco "45" a faster and more economical process.

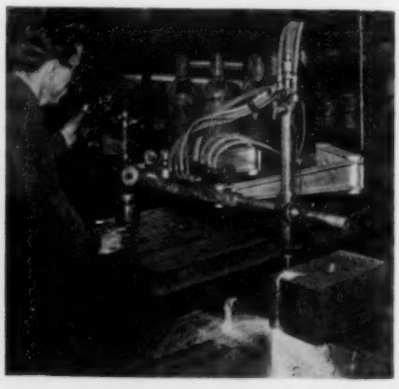


Fig. 1—The Airco "45" High-Speed Machine Cutting Tip with Divergent Nozzle Makes Short Work of Cutting Out a Semi-Circular Piece from This 6-In.-Thick Alloy-Steel Block Used in a Field Gun

Fig. 2—Pieces of Scrap Cut from a 6-In. Alloy-Steel Block Show the Cleanness of Cut Made with the New Tip. The Narrow Stream of Oxygen Moving at High Velocity Burns Through Steel in 20 to 30% Less Time Than if Ejected from the Standard Cutting Tip

Airco "45" high-speed machine cutting tips are available in sizes 0, 1, 2, 3, 4, 6, 8 and 10 for cutting metal thicknesses up to 8 in. The tips fit standard machine cutting torches. To increase cutting speeds 20 to 30 per cent, it is only necessary to substitute one of the new divergent tips for the conventional style tip.

LEAD-SILVER SOLDERS TO CONSERVE TIN

Should tin supplies from the Orient be greatly curtailed or cut off, conservation of present supplies will become imperative. The use of tin-lead solders will doubtless have to be greatly curtailed. A recent report of the American Silver Producers' Research Project, now in charge of Handy & Harman, suggests a possible alternative.

According to this report, two types of lead-silver solders containing no tin are finding increasing use. One of these is the eutectic alloy which contains 2½% silver and 97½% lead. It flows at about 580°F. The other is a proprietary alloy composed of 2.5% silver, 0.25% copper and 97.25% lead. It starts to melt at about 580° F. and flows at about 661° F. These are relatively "soft" solders and should not be confused with the silver brazing alloys and "hard" silver solders having melting points of 1175 to 1600° F.

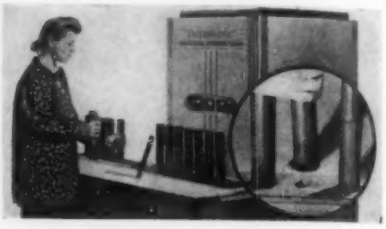
In suggesting the use of the above lead-silver soft solders for cans and other containers, the report points out that a lead-silver solder containing 2.5% silver costs less than lead-tin solders in which the tin content is above 25%. This is significant, since the much-used tin-lead soft solders contain 50% of tin. As the lead-silver solders have higher melting points than the lead-tin solders, higher temperatures can be applied in baking synthetic coatings used as linings, especially in beer cans.

Since there is sufficient silver in the world market, silver is receiving consideration as a possible replacement for other metals the supply of which is restricted.

PRODUCTION BRAZING

One of the features of this particular job is the ease and simplicity of its operation. Thermonic induction heating is applied instantly by push button control. A continuous flow of production follows at the rate of 10,000 units a day. Skilled labor is not necessary. After the preliminary setup no adjustments need be made. The operation is automatic, and there are no rejects because every unit is exactly the same.

The temperature is controlled exactly to the brazed area and areas adjoining, with no annealing beyond, and no metallurigical change.



Another important feature is the cost of this Thermonic Heat. One-tenth of a cent per braze (based on 2¢ per kw.-hr.) is the remarkably low cost, which is a factor in these days of current saving

Seven units are brazed at one time, using a silver-brazing alloy which penetrates instantly through the joint. The strength of the braze is as high or higher than the solid parts. As this joint is free from internal oxidation, the need for cleaning or other maintenance is greatly reduced.

The effectiveness of this particular job may suggest other brazing or metal-treating operations which will facilitate the production and decrease the cost o labor and materials.

A.C. ARC WELDERS

Shober Sales, Inc., of Stockton, Calif., announce that their new line of A.C. arc welders called the "DIALARC" is now ready for nationwide distribution. The DIALARC is as simple to operate as the modern radio. Any heat can be had by a mere turn of the dial, which led to the adoption of the trade name, DIALARC.

The heat range of the model K200 of the DIALARC is 15 to 230 amp. and of model K300 from 15 to 300 amp. The DIALARC's design is so flexible that welders can be built with heats as low as 1 amp. or as high as 2000 amp.

The open-circuit voltage of the DIALARC is 80 v. and is *constant* from the lowest to the highest heats.

The DIALARC's housing is also exceptional and contributes to the many startling features of this A.C. welder. The use of steel in this casing was minimized without sacrifice of sturdiness. All four panels and the top to the housing are made of non-magnetic asbestos cement material. This non-magnetic housing prevents "damping out" of the arc as well as assuring a fast, snappy welding arc.

One of the interesting sidelights of the great war program is the impetus given to inspection by X-ray.

As pioneers in the field of industrial X-ray, we will be glad to consult with you and study your requirements. There are KELEKET representatives in 64 industrial centers who will advise the quickest and most practical way for your plant to either adopt or extend X-ray inspection. Write us today.

THE KELLEY-KOETT MFG. CO., COVINGTON, KY.

Representatives in 64 Cities

KELEKET X-RAY

INDUSTRIAL EQUIPMENT

The Kelley-Koett Mfg. Co.
218-3 West Fourth Street
Covington, Ky.

• Without obligation, please advise how KELEKET equipment can be used profitably in this plant for inspection of

Name .....
Firm Name .....
Address ..... State .....
City .....

PIONEER CREATORS OF *QUALITY* X-RAY EQUIPMENT SINCE 1900

MAGNI-RAY

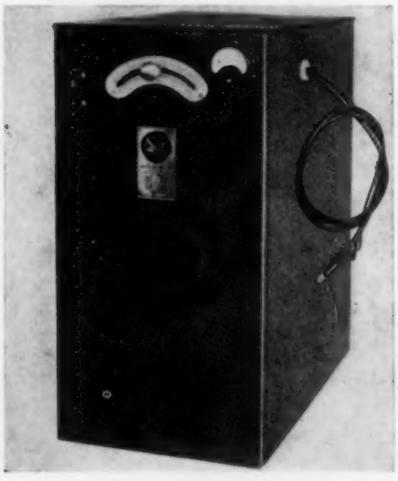
The Magni-Ray gives a clear, undistorted magnification combined with strong, evenly concentrated illumination using two 110-volt bulbs.

Magni-Ray quickly detects these troublesome and costly sources of delay and waste and imperfect welding seams. George Scherr Co., 128 Lafayette Street, New York.

HIGH-FREQUENCY HEATING FOR BRAZING

This new Ajax-Northrup 6-kw. high-frequency self-contained brazing unit has a capacity of brazing 75 2-lb. bombs per hour. After the surfaces are prepared, a ring of compound is placed in position, the assembly heated by placing it inside the induction ring, and then the parts are brazed, with no residue to clean up.

The heat is localized—the joint always the same—practically 100% perfect—and the time is one-third of that required for welding.

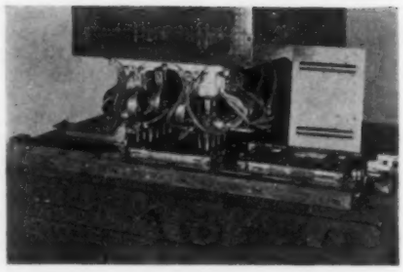


For greater quantity production, small high-frequency generators are used. For example, a 50-kw. high-frequency generator and inductors and controls will braze 1200 2-lb. bombs per hour, or will braze the adapters on 155- or 105-mm. chemical shells at the rate of five per minute.

Complete information on the application of high-frequency equipment for heating and melting will be furnished by the Ajax Electrothermic Corporation, Trenton, N. J.

DOUBLE-SHUTTLING SPEEDS HYDROMATIC WELDING

Welding of reinforcements in ammunition box ends has been speeded by this Hydromatic welder which incorporates an unusual fixture shuttling mechanism and was developed by Progressive Welder Company, 3050 E. Outer Drive, Detroit. At the right of the fixture may be noted the assembled part, the job being to weld the channels to the flat plate. With the fixture at the right, the channels and box end are dropped in place and clamped.



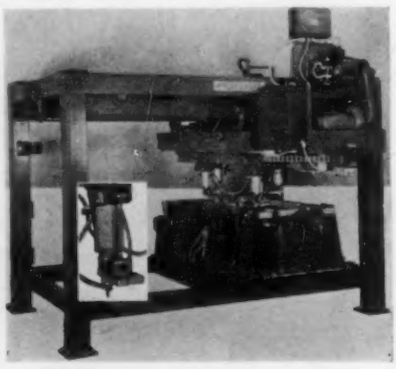
The fixture shuttles to the left below the welding point, where sixteen welds are performed automatically. While the assembly is being welded the left end of the fixture has moved to the left of the welding head and an assembled box end is removed and parts for another clamped in place.

The fixture now shuttles back to the right and the second finished assembly is removed. Thus, only two stations are necessary in the fixture, although there are two loading positions and one welding position and no time is lost in loading. Production is at the rate of some 300 assemblies per hour.

THEY WELD AS THEY WALK

Knee-action, walking welding guns are the latest innovation in the resistance welding field. Developed by Progressive Welder Company, 3050 E. Outer Drive, Detroit, they permit the performing of multiple welds in sequence in an automatic machine, where it is preferable to hold the work stationary in large fixtures. The manner in which this is done is illustrated in a machine developed for welding the back panel into a refrigerator shell.

The machine is designed to handle two sizes of such shells, and welds one assembly while another is being loaded and unloaded. Shell and back panel are dropped over the locating fixture, which incorporates the lower electrode. Clamping is by air pressure. (One fixture has been removed here to show the clamping mechanism at the side of the fixture.) When a button is pressed, the entire operating head of the machine moves to a position above the loaded fixture. Pushing another button starts the automatic welding operation. The four gun points come down and make four welds (pairs of guns weld in series). At the same time the chain shown has started to move. The motion of this chain is continuous, carrying the heads of the welding guns



along. Weld time is controlled by an electronic timer. When the weld is completed, the pressure is off the gun points, and these points swing, under spring pressure, to a new position farther along (depending on the amount the chain has moved). Another weld is made automatically, and the guns take another step.

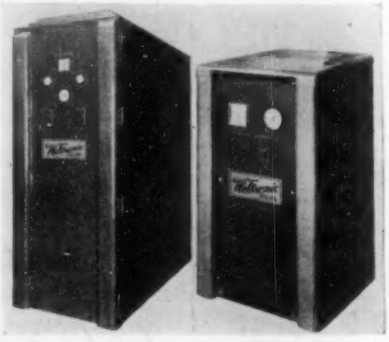
Note the parallelogram construction at the guns, which permits the top of the gun to move while the electrode is stationary.

To complete one assembly, each gun takes 19 steps and makes 20 welds, $1^1/_2$ inches apart. While the shell is being welded, the other fixture is being unloaded and re-loaded. The machine operating head now moves above over the second fixture and repeats the cycle, except that the movement of the guns is now in the opposite direction, the chain reversing its travel at the end of each complete cycle of welds. Offtime, between welds, to permit the guns to move on to the next spot before welding current comes on, is controlled automatically by a notched timing disk.

Time for the complete welding cycle is approximately 12 seconds, during which time 80 spot welds are made.

REFRIGERATED WELDING

The acquisition of all patent, manufacturing and sales rights to the new type of refrigerating units for welding machines originally developed by Progressive Welder Company has been announced by the Weltronic Corporation, East Outer Drive, Detroit. Under the new trade name of "Frostrode" the units will be manufactured and marketed to welding equipment manufacturers hereafter by Weltronic's new Frostrode Division.



Sales of the "Frostrode" units to users will be handled by manufacturers of welding equipment and the York Ice Machinery Company and installations will be under the supervision of either Weltronic Corporation, York Ice Machinery Company, or the welding equipment manufacturers.

Service of the units will be handled by the nearest York Ice Machinery representatives.

The new Weltronic "Frostrode" units are available in five standard sizes, ranging in their capacity from light steel spot welding for the small unit, to the largest unit for use with either a heavy steel welder or a bank of eight aluminum

welders. Completely self-contained, the refrigerating units are quite simple to install.

The Weltronic "Frostrode" welding process has been developed primarily for those tough welding jobs where water-cooling has proved inadequate, such as in the welding of aluminum or heavy steel sections. The units, however, make possible a material reduction in operating costs for resistance welding equipment of all types.

The new units make practical continuous welding of four to ten times as many spots in aluminum without requiring point dressing. Aluminum is one of the most critical metals to weld due to the low electrical resistance and high current values required, with the resulting inclination toward alloying of the metal with the electrode because of the high heat generated.

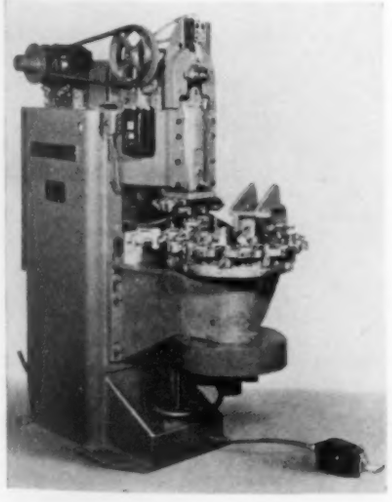
20-MM. SHELL WELDER

This is the latest of a series of Thomson-Gibb Resistance Welding Machines designed to attach a base plate or sealing disk to the base of aircraft, anti-aircraft and artillery shells. The model shown performs this operation on 20-mm. shells which are the size used in many cannon-carrying planes and light anti-aircraft artillery.

The seal is made by a projection weld around the entire outer edge of the disk. Sealing the base of the shell in this manner has proved a fast, cheap and safe way of avoiding the danger of possible leakage through the shell which might cause premature explosion.

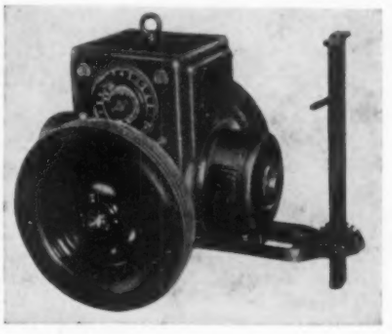
The machine is basically a Thomson motor-driven welding press powered by a 75-kva. transformer and equipped with a ten-station automatic dial feed. The operator loads the shells and disks by hand, but, thereafter, operation is entirely automatic, including ejection of the welded shell onto a chute or conveyor.

The weld is gas and flame-tight and is made by a ring projection on the disk which welds to the flat end of the shell. Accurate position is insured by an ingenious clamping mechanism which locates the shell and disk and applies a positive gripping action as each station reaches welding position. A tripping device opens the clamps and ejects the welded shell before each station returns to the loading position. When directly in front of the operators the vertical and horizontal clamps are wide open for easy loading.



TRAILER WELDER

A new two-wheeled, lightweight, pneumatic-tired trailer for mounting 200-, 300-, 400-amp. Hobart electric drive welders is now in regular production at Hobart Brothers Company, Troy, Ohio. Designed for road towing up to 35 miles per hour, this unit will prove very useful for hurry-up trips to different locations for emergency production, maintenance and repair work. Trailer is so designed that mounting it is accomplished easily by means of three bolts in frame of trailer which register with three holes in the legs of the welding machine. Combination



tow bar and standing support has a hand-operated ratchet for locking support arm in position. Unit is easily moved by hand by virtue of its low, underslung construction, narrow tread and precision method of balancing. This all arc-welded steel trailer is capable of trailing over very rough terrain. Measures 54 in. long, 45 in. wide, 27 in. high (over tires), 13 in. axle center. Tires are 16 x 5.50, 4 ply.

WELDED TEST JACK

The training of hundreds of new welding operators throughout the country to meet war demands has made it necessary to test the work of new welders faster than ever before and at the same time more carefully.

To speed tests of welds, technicians at the B. H. Leonard Welding School of St. Louis, Missouri and the Midwest Piping and Supply Company, designed the all-welded test jack shown herewith.

The device, a front view of which is shown in the photo, consists of a sturdy frame built around a hand-operated hydraulic jack. It is used for making free-bend, side-bend and back-bend tests on weld coupons. The organization uses it as standard equipment for testing arc welding operators on field construction jobs.

The hydraulic jack used is rated at eight

Photo courtesy Lincoln Electric Co.

tons, so the frame had to be sturdy to stand the strain.

The side and top members of the frame were made of mild steel, 6 in. wide and $^1/_2$ in. thick. The side pieces are approximately two feet long and the top members 9 in. The bottom base plate is 9 in. square and 1 in. thick.

The male member of the die is $1^1/_2$ in. by 2 in. by 6 in. The upper end was machined on a $^3/_4$-in. radius and the lower end welded to the upper surface of the jack.

The female part of the die also was 2 in. thick and its curved portion was machined on a $1^3/_{16}$-in. radius. The lower corners of the female portion of the dies were rounded off as shown.

DEEP GIRDERS FABRICATED

A new development in the field of steel fabrication which opens entirely new vistas in design of many structures, including buildings, bridges, large machines and many types of heavy mechanical equipment, is the use of arc welding in fabricating special shapes which are not available for mills as standard rolled members.

As a result of this method, the architect or designer can give free rein to his abilities and incorporate the most advanced features in his designs. No longer need he be restricted by lack of desirable structural elements to carry out his ideas of most advanced design.

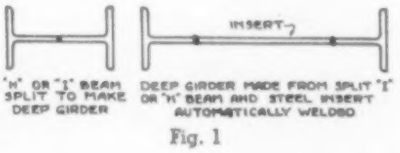


Fig. 1

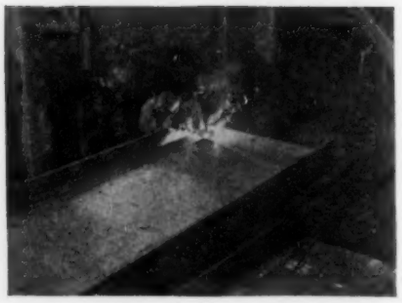


Fig. 2—This Picture Shows an Operator Manipulating an Automatic Welder on a Big Job—the Fabrication of a Girder 35 Ft. Long and 5 Ft. 7 In. Deep

This new development is utilized in fabrication of deep girders for use in manufacturing equipment for the U. S. Navy by the Dravo Corporation, Pittsburgh, Pa. The method utilizes automatic carbon arc welding.

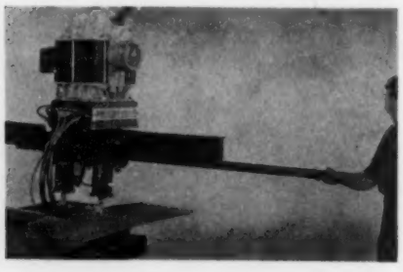
The concern, finding it impossible to obtain deep girders of the proper dimension for the work, decided to insert web plate between the portions of a split I-beam, as shown in the sketch (Fig. 1).

To do work such as this quickly and well, the company used an "Electronic Tornado" automatic welding head mounted on a post arrangement.

In Fig. 2 may be seen an application of this fabricating principle, where an H-beam 12½ in. deep with 15½-in. flanges and web ⅞ in. in thickness is split and a 7/16-in. x 54-in. plate is inserted to make an extremely deep and heavy girder. This particular girder is 35 ft. long and 67 in. deep, with a 7/16-in. web and 15½-in. flanges.

LOW COST STRIP WELDER

An ingenious and low cost installation for welding together ends of strips has recently been developed by Progressive Welder Company, 3050 E. Outer Drive, Detroit, Mich. Shown on the accompanying illustration, it consists of two simple air-operated series connected guns for spot welding, a notched bar to locate welds and a control handle to move the gun along, the entire assembly being supported from an I-beam section above which is located the welding transformer. To weld strips together, the operator moves the gun to the first notch. This trips a switch, causing welds to be made. The gum is pulled along to the second notch causing another pair of welds to be made, etc., for as many welds as needed for the specific strip width. A button is provided on the control handle to prevent closing of the welding circuit when the gun is returned to starting position.



ARC-WELDING FILM IN COLOR WILL SPEED DEFENSE TRAINING

Further evidence of the way industry is rallying to supply the needs of National Defense is the new Hollywood produced all-color training picture, "Inside of Arc Welding."

This film now ready for release to schools and training groups, after six months of preparation, was produced by Raphael G. Wolff, and is designed to speed up the training of the thousands of apprentice welders required for the building of ships, planes, tanks and other armaments.

Because of its content of heretofore unphotographed phenomena "Inside of Arc Welding" will be of unusual interest to experienced as well as apprentice welders. It illustrates the techniques of arc control and electrode manipulation, and actually shows what goes on inside the electric arc

Anyone interested can obtain complete information on cost and method of distribution by writing Raphael G. Wolff Studios, 1714 North Wilton Place, Hollywood, Calif.

Employment Service Bulletin

POSITIONS VACANT

V-110. Associate Welding Engineer wanted for Government work. Four years of college work leading to a Bachelor of Science degree in Engineering. Degree to be preferably in metallurgical, electrical or mechanical engineering. A minimum of three years of progressive professional welding engineering and/or metallurgical engineering closely allied with welding. This experience including at least two years of moderately difficult and important work which has demonstrated the applicant's initiative and resourcefulness, and ability to perform difficult engineering under only general supervision. Desired age 27–35. Fit physical condition with proper ambition and spirit of cooperation. Salary $3200 per year for basic 40-hour week. The work week at present is 48-hour minimum with time and one half pay for all time over the basic 40-hour week. This makes the present annual salary for the position over $3800.

V-111. Welders with shipbuilding experience wanted for a shipyard for the U. S. Maritime Commission building cargo ships.

V-112. Young metallurgist to assist in connection with development of welding electrodes and welding processes.

SERVICES AVAILABLE

A-431. Welder desires position. Have taken a three-position Navy welding test and have had seven months' experience with the Sun Shipbuilding and Dry Dock Co. Have had training in electricity, drafting and some training in metallurgy.

CALENDAR OF EVENTS

Society and Section Meetings

(For further details see Section Activities)

PHILADELPHIA SECTION—March 16, 1942.
EIGHTH LECTURE NEW YORK SECTION LECTURE COURSE—March 17, 1942.
NORTHERN NEW JERSEY—March 17, 1942.
PITTSBURGH SECTION—March 18, 1942.
LOS ANGELES SECTION—March 19, 1942.
CHICAGO SECTION—March 20, 1942.
MARYLAND SECTION—April 17, 1942.
NINTH LECTURE NEW YORK SECTION LECTURE COURSE—March 24, 1942.
PEORIA SECTION—April 1, 1942.
CLEVELAND SECTION—April 8, 1942.
DETROIT SECTION—April 3, 1942.
NORTHWEST SECTION—April 9, 1942.
OKLAHOMA CITY SECTION—April 9, 1942.
COLUMBUS SECTION—April 10, 1942.
ST. LOUIS SECTION—April 10, 1942.
BOSTON SECTION—April 12, 1942.
LOS ANGELES SECTION—April 16, 1942.
MARYLAND SECTION—April 17, 1942.
BOSTON SECTION—April 18, 1942.
PHILADELPHIA SECTION—April 20, 1942.
NORTHERN NEW JERSEY—April 21, 1942.
DETROIT SECTION—May 1, 1942.
PEORIA SECTION—May 6, 1942.
OKLAHOMA CITY SECTION—May 7, 1942.
COLUMBUS SECTION—May 8, 1942.
ST. LOUIS SECTION—May 8, 1942
MARYLAND SECTION—May 15, 1942.

Meetings of Other Societies

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Spring meeting, March 23–25, 1942, Houston, Tex.
FIRST WESTERN HEMISPHERE FOUNDRY CONGRESS FOUNDRY AND ALLIED INDUSTRIES SHOW, 46th Annual Convention, April 20–24, 1942.

SECTION ACTIVITIES

BOSTON

At the January 12th meeting, the Section made an evening visit to Wentworth Institute, Boston. Frederick E. Dobbs, Principal of Wentworth Institute, welcomed the group to the Institute, explained its purposes, the methods used in training young men in the mechanic arts and the requirements for admission. The group then visited the following departments which had classes in session: Machine Shop, Foundry and Welding, which is headed by G. F. Tapp, a member of this Section. Demonstrations were also made of the testing of welds.

A joint meeting of this Section with the Boston Section, American Society of Mechanical Engineers, was held on February 12th, in Pritchett Hall, Massachusetts Institute of Technology. At this meeting, Mr. Roy W. Emerson, Metallurgist of the Pittsburgh Piping and Equipment Company, spoke on the subject "Fabrication of Piping for High-Temperature and High-Pressure Service."

The Second New England Welding Conference scheduled to be held at the Massachusetts Institute of Technology on April 18th has been cancelled due to the war situation, and a regular Section meeting will be held on April 12th.

CHICAGO

Meetings of the Chicago Section held so far this season have been very well attended and the programs presented have proved extremely interesting. As has been the custom for several years, the regular meetings are held the third Friday of each month at the Auditorium of the Chicago Lighting Institute in the Civic Opera Building. Prior to each meeting, a get-together dinner is given at Eitel's Restaurant in the Northwestern Station located a block away from the meeting place. This gives a good opportunity for the members who participate to become better acquainted and promotes better fellowship. The response to these affairs has been very gratifying.

The January 16th meeting featured Mr. Ernest Kuehn, Factory Manager, Electro-Motive Corp., La Grange, Ill., as the speaker. Mr. Kuehn, who has been associated with the development of streamlined locomotives and Diesel engines for many years, related why welding was adopted as a means of fabrication of Diesel-electric locomotives and internal combustion engines. The speaker revealed that the welds in these important train units are highly stressed and give unfailing performance making high-speed operation possible combined with light weight. Prior to the speaker's appearance on the program, a sound movie "Diesel on the Railroad" was shown depicting the history of streamlined trains leading up to the present-day modern engines in service on various railroads.

The February meeting was held on the 20th. The subject was "Non-Destructive Weld Testing Methods. A Symposium on X-Ray, Gamma Ray and Magnaflux" by speakers from General Electric X-Ray Corp., Radium Chemical Co. and Magnaflux Corp. This program proved extremely interesting and was presented to better acquaint members of the welding fraternity with the methods employed in making weld examinations, especially since many defense items require such tests.

The programs for the coming meetings are as follows:

March 20th—Symposium on Resistance Welding. Mr. C. I. Pfeiffer of the Western Electric Co. will give the introductory talk on the theory and will introduce speakers from the National Electric Welding Machines Co., the Federal Machine and Welder Co., Thomson-Gibb Electric Welding Co. and the Taylor-Winfield Corp., who have been invited to participate. Each speaker will deal with a particular phase of the subject.

April 17th—"Shape Cutting and Flame Hardening." Speaker to be announced.

May 15th—"Certified Weldments" by R. W. Sternke of the Lakeside Bridge and Iron Co., Milwaukee, Wis. The speaker's company is engaged in the fabrication of much important equipment where controlled welding is employed and he has an interesting story to tell.

CLEVELAND

G. N. Sieger, president S-M-S Corporation, Detroit, was the speaker at the February 11th meeting of the Cleveland Section at Cleveland Engineering Society Hall.

Sieger's subject, "Resistance Welding," developed the thought that many difficulties experienced in resistance welding result from failure to understand and apply the fundamentals underlying this method.

The speaker demonstrated the simplicity of the method and dispelled the theory that the process is one of "dark magic."

The Coffee Talk, "Something About Seeing," was given by Dr. Matthew Luckiesh, director lighting research, Nela Park, Cleveland. Dr. Luckiesh has been director of lighting research since 1924 and has many inventions to his credit. He is a graduate of Purdue University, class of 1909, and received his doctor's degree from Iowa State College in 1926.

The Cleveland Section is continuing its drive for new members under the direction of Ray Metzger, chairman of the membership committee.

"Weldrama of 1942," a welding variety show with J. T. Lewis acting as master of ceremonies is scheduled for Wednesday, April 8th.

Members have been reminded of the Spring Conference scheduled for May.

COLUMBUS

At the regular monthly meeting of the Columbus Section held on February 13th Mr. F. G. Flocke, Welding Engineer in the Development and Research Division of The International Nickel Co. Inc., spoke on the subject of properties and fabrication of Monel, nickel and Inconel. Mr. Flocke also covered the forming and shaping of these materials; the joining of them by welding, silver brazing and soft soldering; and the forming and welding in clad plate construction.

April 10th—Dinner Meeting—Hotel Fort Hayes, "Preheating—Welding—Normalizing," by C. J. Holslag, Electric Arc, Inc.

May 8th—Meeting—Battelle Memorial Institute. To be announced later—Col. G. F. Jenks, President, AMERICAN WELDING SOCIETY.

DETROIT

The Detroit Section had another exceptionally good National Defense meeting. Because of the great number of tanks scheduled for production in this area, the story of "UnionMelt in the Defense Program" by Ed Morris, The Linde Air Products Co., answered the questions suggested by the showing of UnionMelt films, as well as specific problems. The audience was large, interested and most intelligent questions were propounded.

April 3rd—"Stored Energy Welding" by Mr. Maurice Sciaky, Sciaky Bros., Chicago, Ill. Mr. Sciaky will be assisted by C. W. Dodge, Chief Engineer. The development of stored energy welding is one of the revolutionary processes in aluminum fabrication. Mr. Sciaky's organization is one of the pioneers in this type of welding and his presentation will not only be interesting from the historical viewpoint, but also from the accomplishment viewpoint.

May 1st—"Past Chairmen's Night, Ladies' Night, House of Magic." Following the successful experience of last year, the Section will honor those chairmen who have been responsible for the continuity

of its activities. There will be no speeches as such, but there will be entertainment in the form of "House of Magic" and dancing which will prove of interest not only to members, but also to their wives and sweethearts.

KANSAS CITY

The regular monthly meetings of the Kansas City Section have been held like clock work.

Attendance at the last six meetings has shown a marked increase and as a means of stimulating interest we have adopted a plan of giving a door prize of two dollars in defense stamps to the lucky man.

These meetings were exceptionally interesting and talks was given on February 3rd by Mr. G. A. Sellers, Professor of Metallurgy of Kansas State College, Manhatten, Kans., on "Welding Metallurgy."

LOS ANGELES

The AMERICAN WELDING SOCIETY, Los Angeles Section, held its annual Christmas party on Thursday, December 18th, at Scully's Cafe in Los Angeles. Approximately 150 persons attended, including both members and their guests, and the affair was acclaimed a huge success by all present.

The entertainment program was exceptionally interesting. Mr. Howard Hill World Champion Field Archer, showed his motion picture, "The Last Wilderness," and further entertained with some exhibition target shooting. Some of the most difficult feats which he performed were shooting 50¢ pieces as they were thrown into the air, and also shooting from a prone position with his feet, as well as his hands. He called his shots and never missed.

Another feature was the showing of a moving picture entitled "Tobacco Land." This was a colorful picture illustrating the story of tobacco growing in the South and was not only interesting but educational.

At intervals throughout the program, musical selections were offered by the "Three Musicians," a well-known string trio who have often been heard on the major networks. Vocal selections were also offered by Michael Marsman, Baritone, Director of the Vega Aircraft Corporation Choral Club.

All in all it was a highly successful party. The Christmas spirit flowed freely, and everyone planned to attend all meetings in 1942.

The first meeting of 1942 was held on Thursday, January 15th, again at Scully's Cafe in Los Angeles. Mr. Joseph P. Weed, General Welding Foreman of the North American Aviation Company, Inglewood, spoke on "Aviation Welding of Light Gauge Tubing." Mr. C. W. Roberts, Superintendent of Southwestern Engineering Company, and Past Chairman of the Los Angeles Section of the AMERICAN WELDING SOCIETY also spoke. His topic was "Development of Welded Pressure Vessels." Following Mr. Roberts' talk, there was an informative discussion led by Mr. C. O. Meyers, Secretary-Treasurer of the National Board of Boiler and Pressure Vessel Inspectors.

It was an interesting and highly worth while meeting for everyone.

Of special interest to our members is the information that there is a $15,000,000 aluminum rolling mill going in the Torrance district in Southern California. The General Motors Plant in Los Angeles will soon be on full scale defense production.

The Western Pipe & Steel Company have now had Naval approval of their lease in the San Pedro district and are purchasing equipment for building ways for the construction of vessels for the U. S. Navy.

The Section recently had the pleasure of a visit from Lt. Commdr. Blake from the Bureau of Ships, U.S.N., past-chairman of the Section, and he gave a very highly patriotic talk at our December meeting.

Other meetings are:

March 19th—"Low Temperature Brazing Shipbuilding."

April 16th—"High Velocity Tensile Testing of Welds"; "Aviation Welding of Large Jigs."

MARYLAND

The following is the program for the remainder of the season for the Maryland Section.

April 17, 1942—Subject: "Electric Resistance Welding." Speaker: J. R. Merriman, Glenn L. Martin Co.

May 15, 1942—Annual Banquet and demonstrations.

MILWAUKEE

Mr. J. H. Cooper, Welding Engineer, Taylor-Winfield Corp., gave the welding address at the January 23rd meeting of the Milwaukee Section. His address on "Resistance Welding as Applied to Defense Items" dealt with the latest developments and actual samples and parts welded by the flash, butt, seam and spot-welding methods. The after dinner talk was given by Lester J. Bradshaw, Jr., Agency Supervisor, Fidelity & Casualty Co., who gave an inspiring talk on "America—Love It or Leave It."

NEW YORK

The New York Section of the AMERICAN WELDING SOCIETY held its regular February Technical Meeting at the Engineering Societies Building on February 11, 1942. Chairman for the evening was Mr. A. N. Kugler, mechanical engineer, Air Reduction Company.

The first speaker of the evening was Mr. F. G. Flocke who spoke on the subject, "Monel, nickel and Inconel—Their Properties and Fabrication." Mr. Flocke's talk covered the following subjects: (1) General properties of Monel, nickel and Inconel in relation to their fabrication; (2) the forming and shaping of these materials; (3) the joining by welding (electric arc, oxyacetylene and resistance), silver brazing and soft soldering; (4) the forming and welding of nickel-, Monel- and Inconel-clad steel. Mr. Flocke highlighted his talk with numerous lantern slides and blackboard sketches.

Following Mr. Flocke's talk, Dr. William G. Theisinger, Director of Welding Research, Lukens Steel Company, Coatesville, Pa., who presented a motion picture and slides illustrating the casting in the open hearth and the rolling on the 206-in. mill, the world's largest plate mill, of a 93,000-lb. ingot to produce a 76,000-lb. plate. The ingot was one of the largest Luken's has ever cast, and the plate was the heaviest Luken's has ever shipped. Also shown in the motion picture were operations in the spinning of an 18 ft. in diameter head.

As usual, the regular "get-together" dinner of the New York Section was held at Old Timer's Grill. Then, during the half-hour period preceding the technical meeting, the "Welding and Cutting Question Box" session was held under the chairmanship of Charles Kandel, President, Craftsweld Equipment Corporation, Long Island City, N. Y.

NORTHERN NEW JERSEY

The regular monthly meeting of the Northern New Jersey Section was held on February 17th at the Essex House, Newark, N. J. Mr. F. H. Frankland, Director of Engineering, American Institute of Steel Construction, outlined the course taken by the AMERICAN WELDING SOCIETY in cooperation with the American Institute of Steel Construction in improving the application of welding to steel structures.

Mr. H. M. Priest, Engineer, Railroad Research Bureau, U. S. Steel Corporation, presented a discussion of the engineering aspects of welding residing in the hands of the welders and those immediately responsible for fabrication and erection of welded structures.

"Welding Freight Cars" was a movie shown through the courtesy of Pullman-Standard Car Manufacturing Company.

March 17th—"Welding of Nickel Alloys," T. N. Armstrong, International Nickel Co. "Welding of Chrome Alloys," A. B. Kinzel, Union Carbide and Carbon Res. Labs. Inc. Movie: "Nickel High Lights."

April 21st—"Welding in the Pressure Vessel Industry," J. T. Phillips, Supt., Boiler Shop, Foster Wheeler Corp. Movie: "Manufacture of Large Diameter Pressure Vessels."

NORTHWEST

Mr. Howard L. Miller, Metallurgical Engineer, Alloy Steel Division, Republic Steel Corporation, spoke on "Welding in Defense" at the February 11th meeting. Mr. Miller's talk was full of practical ideas and suggestions of benefit to all.

March 19th—"Welded Steel Structures," by LaMotte Grover, Air Reduction Sales Co.

April 9th—"Metallurgy of Welding," by E. C. Chapman, Combustion Eng. Co.

May 14th—Annual Meeting.

OKLAHOMA CITY

The Welders Training Course at the University of Oklahoma has an additional

instructor, and has completed the installation of seven new arc-welding stations. Trainees from this Course are found in practically every shipbuilding plant on the West and Gulf Coasts, and in many of the yards along the Atlantic Coast. More than 650 men have received training.

A picture entitled "There's a Job to be Done" was presented through the courtesy of the Allegheny Ludlum Steel Corporation at the February 5th meeting. Mr. L. E. Dietrich, Chief Instructor for the Welders Training Course at the University of Oklahoma gave a short talk descriptive of a weld testing press.

April 9th—C. I. Lundgren, the Wichita Representative of the Taylor-Winfield Corp. of Warren, Ohio, who will speak on "Resistance Welding."

May 7th—Arthur N. Kugler, Mechanical Engineer, Applied Engineering Department, Air Reduction Sales Company, New York City, N. Y. Subject: "Designs of Jigs and Fixtures for Welding." Dinner Meeting, Biltmore Hotel, 6:30 P.M.

June 4th—Annual meeting, installation of officers and Dutch Lunch.

PEORIA

On February 4th the Peoria Section was very privileged in hearing Mr. A. W. Harris, Maintenance Engineer, from Western Cartridge Company, East Alton, Illinois. His paper on "Testing and Control in Job Shops Is Profitable" was well received by the sixty members and guests who braved the weather to hear his illustrated lecture. Mr. Harris successfully impressed the group with his story on cost reductions due to having repetitive maintenance jobs laboratory tested for minimum weld sizes. He also elaborated extensively on the fact that Western Cartridge Company has taken all but a few of their hundreds of maintenance jobs and segregated them into ten distinct classes for which they have independently set up a standard or written procedure governing the repair of each. This is truly a miracle when one stops to visualize the constant flow of breakdowns which must occur to justify that Company employing twenty-three full time welders for their maintenance department.

At the Annual Business Meeting on January 14th the following officers and directors for the Peoria Section for 1942 were elected: *Chairman*, Clifford Wimmer, Keystone Steel & Wire Co.; *Vice-Chairman*, Eldon Warnke, R. G. LeTourneau, Inc.; *Secretary*, Phil Sommer, R. G. LeTourneau, Inc.; *Treasurer*, Robert R. Rutledge, A. Lucas & Sons.

Executive Committee to serve for two years: John Hanley, A. Lucas & Sons; Art Secretan, Bradley College; Walter J. Brooking, R. G. LeTourneau, Inc.

Present Directors with one more year: John F. Reist, Keystone Steel & Wire Co.; Elmer Isgren, R. G. LeTourneau, Inc.; W. Hardbarger, R. G. LeTourneau, Inc.

The April meeting will be held on the 1st. Mr. E. R. Fish, Chief Engineer, Boiler Division, Hartford Steam Boiler Insp. & Ins. Co., will speak on "Boiler and Insurance Underwriter Standards." Moving Picture: "Construction and Operation of Diesel Engineers."

The May meeting will be held on the 6th. Mr. C. J. Holslag, Electric Arc, Inc., will speak on "Crater Cracks and Fish Eyes, Their Cause and Cure." Moving picture: "Smelting and Refining of Lead."

PHILADELPHIA

The regular monthly meeting of the Philadelphia Section of the AMERICAN WELDING SOCIETY was held Monday evening, January 19, 1942, at the Engineers Club.

The speaker of the evening was Dr. John Miller who was introduced by Mr. R. D. Thomas, President of Arcos Corp. Dr. Miller gave an excellent talk on the materials and processes for making arc-welding electrodes. Several guests were present, including Mr. A. G. Bissell, Commander J. C. Blake of the Bureau of Ships and Mr. Claude Holslag of the Electric Arc Welding and Cutting Machine Co. Also present were Mr. Ellinger of the Bureau of Standards and Mr. Earl McCambridge of the Phila. Navy Yard.

Each of these men added materially to the discussion and helped make the meeting a real success.

March 16th—"More Important Fields for Gas Welding," by A. N. Kugler, Air Reduction Sales Co.

April 20th—"Structural Welding," by H. W. Lawson and W. F. Carson.

May 18th—"The Welding of High Pressure Piping." Speaker to be announced.

PITTSBURGH

One hundred forty-eight members and guests attended the January 21st meeting of the Pittsburgh Section in the Mellon Institute of Industrial Research Building and heard Mr. R. W. Emerson, Metallurgist and Welding Engineer of the Pittsburgh Piping & Equipment Company deliver a most interesting and complete discussion on the "Fabrication of Welded High Pressure Piping."

The presentation covered the welding design and procedure used in the fabrication of high pressure piping systems, metallurgical problems and controls necessary to produce satisfactory welds to meet U-68 and P-102 requirements of the A.S.M.E. Boiler Code.

Using over sixty extraordinary films showing welds of all kinds and descriptions, Mr. Emerson was able to put over a very clear story of the problems confronting the pipe manufacturing industry.

Following the talk there were many questions asked by those present and satisfactory answers were given. Particular interest seemed to center in the use of gamma-ray radiographic inspection of welds and the manner in which the inspections are made.

At the March 18th meeting H. Malcom Priest of the Carnegie-Illinois Steel Corporation will be the principal speaker.

ROCHESTER

Mr. E. W. P. Smith, of The Lincoln Electric Company, was the speaker at the February 5th meeting of the Rochester Section. Mr. Smith spoke on the "Study of Stress Distribution, Cost and Procedure Control by Means of Polarized Light." Mr. Smith pioneered in the use of polarized light as an aid in studying stress distribution in and design of welds by means of transparent models.

ST. LOUIS

A joint meeting with the Engineers Club was held on February 12th at the Engineers Club Auditorium. "The Elements of Welded Design" was presented by Mr. Leon C. Bibber, Welding Engineer, Carnegie-Illinois Steel Corp. Mr. Bibber's talk was illustrated with lantern slides and was both entertaining and instructive.

April 10th—"Machine Design," by John D. Gordon, Taylor-Winfield Corp.

May 8th—"Crater Cracks and Fish Eyes, Their Cause and Cure," by C. J. Holslag, Electric Arc Welding Co.

SAN FRANCISCO

Mr. R. O. Waldman of the Chicago Steel and Wire Company spoke on "The Electrode Coating" at the January 23rd meeting. A motion picture "The Electric Arc" was also shown.

SOUTH TEXAS

Chairman J. M. Hughen was dinner host to members of the Executive Committee of the South Texas Section on January 19th, and questions important to activities of the Society were discussed.

Committees for the coming year are made up of three members in good standing, and at the end of each three-month period one member from each committee will be dropped and a new one appointed. The chairmen of the active committees will be the last member replaced under the new plan. Following is a list of committee members.

Membership Committee: H. K. Smith, *Chairman;* W. E. Klauberg, B. W. Farquhar.

Program Committee: L. H. Courtright, *Chairman;* L. D. Sugg, R. F. Arnoldy.

Technical Committee: G. W. Woods, *Chairman;* W. E. Klauberg, T. D. Ketchbaw.

Entertainment Committee: H. K. Smith, *Chairman;* E. C. Jackson, Chas. Cryer.

Periodicals Committee: L. H. Courtright, *Chairman;* E. W. Pittman, E. C. Jackson.

Mr. J. F. Lincoln, President of The Lincoln Electric Co., addressed the regular meeting held on January 19th. Mr. Lincoln reviewed the progress of metal arc welding since its introduction to industry, and expressed the opinion that advancement would be far more rapid in the same period of time immediately

before us. He pointed out that some eighteen million pounds of welding electrode material per month is being used in the present emergency.

WASHINGTON

The fourth regular meeting of the Washington Section was held on January 27th. Mr. H. W. Pierce, Welding Engineer of the New York Ship Building Corporation, described the materials, techniques and processes involved in construction of sub and final assemblies in shipbuilding. The greatly expanded Navy and Maritime program has made it possible for shipbuilders to standardize their procedures in a very efficient fashion.

The speaker described the very interesting "twin arc" welding process suitable for side and vertical welding, wherein one welder works from each side of the double V groove. The arcs from the two electrodes are maintained opposite each other, with the result that complete center fusion is obtained. Macro examinations of such welds show a completely homogeneous central mass of deposited weld metal.

The speaker was detained answering questions for a considerable time after completing his paper, thereby indicating a great interest on this subject. The audience consisted largely of Navy and Maritime commissioned personnel, who greatly benefited by Mr. Pierce's experience.

WESTERN NEW YORK

The January meeting was held at the Markeen Hotel on the evening of the 16th and consisted of a dinner gathering followed by the regular business meeting.

The speaker of the evening, Mr. A. H. Yoch of the Air Reduction Sales Co., spoke on "Machine Cutting in National Defense Work." Mr. Yoch's subject was particularly interesting at this time of speeded up production and his years of practical experience made his talk of unusual value to all his listeners.

YORK-CENTRAL PA.

The regular monthly meeting was held on January 21st. Dr. W. G. Thiesinger, Director of Welding Research of the Lukens Steel Company, presented an address on the "World's Largest Plate Mill." Dr. Theisinger's lecture was accompanied by a colored film which showed the making of steel, the rolling of heavy plate in a 206-in. plate mill and the hot flanging of boiler and pressure vessel heads.

Mr. R. D. Thomas, President of Arcos Corporation was the speaker at the February 18th meeting. Mr. Thomas' subject was "Stainless Electrodes for Welding Air-Hardening Steels."

List of New Members

January 1 to January 31, 1942

BIRMINGHAM

Carlin, H. W. (C), 1220 Maple St., Tarrant, Ala.
Smith, Amasa G. (C), 2899 Thornhill Rd., Birmingham, Ala.

BOSTON

Andrews, Richard (F), M. I. T., Dormitories, Box 36, Cambridge, Mass.
Jackson, Walter P. (D), 77 Howard St., Revere, Mass.
Preston, Myles B., Jr. (D), 338 Commonwealth Ave., Boston, Mass.
Runkle, Lloyd Daniel (C), 19 Maple Ave., Newton, Mass.
Wilhelm, Walter (C), 34 Forest St., Attleboro, Mass.

CHICAGO

Carr, Laurence H. (C), The Edward Valve & Mfg. Co., Inc., 1200 W. 145th St., E. Chicago, Ind.
Casserly, William J. (D), 7344 So. Paulina St., Chicago, Ill.
De Santo, Joseph (C), 12049 Maple St., Blue Island, Ill.
Drab, Frank M. (D), 2512 S. Harding Ave., Chicago, Ill.
Griffith, Mansfield (C), 236 W. 112th Pl., Chicago, Ill.
Meyer, William C. (D), 4025 W. Wilcox St., Cleveland, Ohio.
Robinson, R. W. (D), 1911 Summerdale Ave., Chicago, Ill.
Siewert, William P. (D), 832 Richards St., Joliet, Ill.
Vesly, Rudolph R. (D), 1308 S. Elmwood Ave., Berwyn, Ill.
Youngquist, Arthur (D), 229 W. 104th Pl., Chicago, Ill.

CINCINNATI

Burger, C. J. (B), 1615 Springfield St., Dayton, Ohio.
Smith, Austen J. (B), Lukenheimer Co., Cincinnati, Ohio.

CLEVELAND

Conway, Michael A. (D), 10118 Olivet Ave., Cleveland, Ohio.
Haugh, Ed (C), 805 Woodview Rd., Cleveland Hts., Ohio.
Macpherson, Kenneth E. (C), 1625 Waterbury Rd., Lakewood, Ohio.
Ticknor, William A. (C), 109 W. Glenndale, Bedford, Ohio.
Wilson, Evan F. (B), Babcock & Wilcox Co., Barberton, Ohio.

COLORADO

Bishop, Eldred T. (D), 1431 Tamarac St., Denver, Colo.

COLUMBUS

Tarlton, Russell A. (B), 216 S. Leighton St., Kenton, Ohio.

CONNECTICUT

Nass, Fred A. (D), 23 Arcadia Ave., Stratford, Conn.
Valente, Pat (D), Fuller Brush Co., 3580 Main St., Hartford, Conn.

DETROIT

Bartch, Maura J. (B), American Blower Corp., 6000 Russell St., Detroit, Mich.
Boelter, L. W. (C), Ford Motor Co., Willow Run Bomber Plant, Romulus, Mich.
Di Giulio, Armand (B), Bundy Tubing Co., 10951 Hern Ave., Detroit, Mich.
Dunn, Stephen J. (B), Great Lakes Steel Res. Lab., Great Lakes Steel Co., Ecorse, Detroit, Mich.
Frost, L. H. (B), 7310 Woodward Ave., Detroit, Mich.
Holmes, George (C), Service Iron Wks. 12271 Coyle Ave., Detroit, Mich.
Mihelcic, Joseph (D), 8802 E. Canfield Ave., Apt. 7B, Detroit, Mich.
Moehlenpah, Walter G. (B), Weltronic Corp., 3080 E. Outer Dr., Detroit, Mich.
Rubel, Leon (D), 3225 Burgess St., Flint, Mich.
Schlieter, August C. (D), 63 E. Van Buren St., Battle Creek, Mich.

KANSAS CITY

Curry, Fred. J. (C), 2202 Agnes St., Kansas City, Mo.
Hutchings, Chas. R. (C), Kansas City Structural Steel Co., 3319 Metropolitan Ave., Kansas City, Kans.

LAKE SHORE

Stangel, Harvey J. (C), J. J. Stangel Hdwe. Co., Manitowoc, Wisc.

LOS ANGELES

Brown, R. Earl (C), 4434—12th St., Riverside, Calif.
Call, Leigh N. (C), Victor Equip. Co., 3821 Santa Fe Ave., Los Angeles, Calif.
Dean, E. P. (C), 2201 Howard St., Whittier, Calif.
Porter, Jack (C), Vega Airplane Corp., Plant 2, Burbank, Calif.
Reed, Wm. K. (C), 67 Las Flores Ave., Arcadia, Calif.
Smith, Arthur N. (C), Fruehauf Trailer Co., 6522—2nd Ave., Los Angeles, Calif.
Thomas, J. D. (C), 421 So. La Brea Ave., Inglewood, Calif.

MILWAUKEE

Bennewitz, Robert H. (C), 2707 N. 49th St., Milwaukee, Wisc.

Brown, H. L. (C), 2019 E. Jarvis St., Milwaukee, Wisc.
Free, Hugo E. (C), The Oilgear Co., 3003 N. 58th St., Milwaukee, Wisc.
Loebel, Maurice G. (D), 1752A S. Pearl St., Milwaukee, Wisc.
Jorgensen, Newell (D), 3031 Washington Ave., Racine, Wisc.
Megow, Lawrence F. (C), 3980 N. 29th St., Milwaukee, Wisc.
Roby, Frank H. (B), Square D. Co., 4041 N. Richards St., Milwaukee, Wisc.

NEW YORK

Bauer, G. (C), 1133 E. 35th St., Brooklyn, N. Y.
Blair, Ernest (D), 405 E. 54th St., New York, N. Y.
Bleecher, Rudolph J. (C), 2840 Ocean Ave., Brooklyn, N. Y.
Boss, Charles (C), 137 Franklin St., Elmont, L. I., N. Y.
Brady, Henry P. (D), 130–35 146th St., So. Ozone Park, L. I., N. Y.
Campbell, Hugh, Jr. (F), 43 Purcell St., Staten Island, N. Y.
Connor, Herbert P. (C), 2555 E. 13th St., Brooklyn, N. Y.
Cornell, William C. (C), 319 College Ave., Port Richmond, S. I., N. Y.
Duna, Fred (D), Arma Corp., 254—36th St., Brooklyn, N. Y.
Dunn, Philip E. (C), 208 Clark Terrace, Cliffside, N. J.
Englisby, J. M. (F), 1217 E. 36th St., Brooklyn, N. Y.
Gothinger, Chas. (D), Arma Corp., 254—36th St., Brooklyn, N. Y.
Haakonsen, Ole (C), 7007 Narrows Ave., Brooklyn, N. Y.
Hamer, T. M. (C), 18 Vinton St., Long Beach, N. Y.
Holdridge, Leonard (D), 275 Farrant Terrace, Teaneck, N. J.
Jansson, John H. (C), 692 Larch Ave., Teaneck, N. J.
Kaufman, Leonard (D), 12 Willoughby Ave., Brooklyn, N. Y.
Krauss, Frank (C), 806 Hillside Blvd., New Hyde Park, L. I., N. Y.
Lynch, James A. (D), 7501 Ridge Blvd., Brooklyn, N. Y.
Macri, E. J. (C), 373 Hudson St., New York, N. Y.
Reilly, Edward J. (D), c/o Republic Aviation Corp., Conklin St., Farmingdale, N. Y.
Schnetzer, Siegfried (B), 125 Terrace Ave., Hasbrouck Hgts., N. J.
Vickers, Walter (D), 15–91 Pacific St., Brooklyn, N. Y.
Waldo, Forrest (C), 318 W. 18th St., New York, N. Y.
Walker, Lawrence A. (C), 655 Bard Ave., W. Brighton, S. I., N. Y.
Wise, Frederick R. L. (D), 44 Pleasant St., Great Kills, S. I., N. Y.

NORTHERN NEW JERSEY

Bishop, Levina (D), 65 St. Marks Pl., New York, N. Y.
Bluhm, James D. (C), Westinghouse E. & M. Co., 1180 Raymond Blvd., Newark, N. J.
Boruch, Michael (D), 402 Monroe St., Passaic, N. J.
Bryant, Gordan (D), 89 North 15th St., Paterson, N. J.
Carragher, Frank J. (D), 16 Fairchild Pl., Irvington, N. J.
Du Bick, Edward A. (D), 302 Grand St., Jersey City, N. J.
Du Bois, Charles (D), 44 Wood St., Paterson, N. J.
Friedlander, Lewis (D), 4 Glennon Pl., West Orange, N. J.
Harder, Henry (D), 15 Prince St., Paterson, N. J.
Hoydich, Nicholas (D), 43 Brenner St., Newark, N. J.
Johanson, Henry (D), R. C. A. Mfg. Co., Radio Iron Div., Harrison, N. J.
Lantz, Eric (D), 5205 Boulevard East, West New York, N. J.
Lawrence, Anna M. (D), 239 Munn Ave., Irvington, N. J.
McManus Geo. V. (D), 240 Satterthwaite Ave., Nutley, N. J.
Powers, J. Claude, Jr. (D), 435 Upper Mountain, Montclair, N. J.
Rosso, Charles R. (D), 49 Oberlin St., Maplewood, N. J.
Schott, George (D), 5 Shanley Ave., Newark, N. J.
Schrumpf, Emil A. (D), 682 S. 11th St., Newark, N. J.
Still, R. H. (D), 143 Main St., Manasquan, N. J.

NORTHERN NEW YORK

Anderson, D. (D), 1500 State St., Schenectady, N. Y.
Cady, G. Fitch (C), Welding Laboratory, Rensselaer Polytechnic Institute, Troy, N. Y.
Colaluca, Anthony A. (D), R. F. D. 1, Troy, Schenectady Rd., N. Y.
Conti, Salvatore (D), 1978 Foster Ave., Schenectady, N. Y.
Curcio, Salvan S. (D), 906 Adam St., Schenectady, N. Y.
De Angelo, Francis (D), 555 Florence St., Schenectady, N. Y.
Egry, Julius (D), 710 Cramer Ave., Schenectady, N. Y.
Forgette, Ernest (D), 37 Craig St., Watervliet Colonie, N. Y.
Jensen, H. A. (D), 445—4th St., Schenectady, N. Y.
Knapp, Benjamin H. (D), General Elec. Co., Bldg. 66 Welded Prods. Dept., Schenectady, N. Y.
Marson, Victor J. (D), 25 N. Ferry St., Schenectady, N. Y.
Perretta, Angelo (D), 2048 Van Vranken Ave., Schenectady, N. Y.
Tamburro, Joseph (D), 429 Liberty St., Schenectady, N. Y.

OKLA. CITY

Gebhart, Merle (F), 317 Knoblock, Stillwater, Okla.
Levan, Robert (F), 227 West St., Stillwater, Okla.
Noret, C. C. (C), Box 14, Warr Acres Branch, Oklahoma City, Okla.
Roffety, Kenneth D. (F), 914 W. 6th, Stillwater, Okla.

PEORIA

Johnson, Russell A. (C), Anthony Co., Inc., Streator, Ill.
Stewart, Clarence H. (C), Anthony Co., Inc., Streator, Ill.

PHILADELPHIA

Anderson, Fred M. (C), Phila. Range Boiler & Tank Co., Coatesville, Pa.
Cronin, Francis J. (D), 1646 S. 26th St., Philadelphia, Pa.
Dods, John P. (A), Summerill Tubing Co., Bridgeport, Pa.
Kuehner, Martin R. (D), 4211 E. Tudor St., Philadelphia, Pa.
Maxwell, Harold L. (B), E. I. Du Pont de Nemours & Co., Eng. Dept., Experimental Sta., Wilmington, Del.
Meixel, V. V. (D), 439 E. Barber Ave., Woodbury, N. J.
Noy, Jack M. (C), 70 College Ave., Flourtown, Pa.
Ripple, Lotus (D), 4607 Springfield Ave., Philadelphia, Pa.
Scanlan, M. Ward (C), 4644 Penn. St., Philadelphia, Pa.
Schlenker, Martin (C), 2318 N. Broad St., Philadelphia, Pa.

LOUISIANA

Williams, E. B. (B), Delta Shipbldg. Co. Industrial Canal, New Orleans, La.

MARYLAND

McHugh, Paul L. (C), Arbutus Ave., Catonsville, Md.
Murray, Thomas O. (C), 111—5th Ave., Brooklyn Park, Baltimore, Md.

PITTSBURGH

Allison, M. R. (C), P. O. Box 62, Rennerdale, Pa.

PUGET SOUND

Beede, Howard C. (F), 102 E. 80th St., Seattle, Wash.

ROCHESTER

Ellinwood, Herman G. (C), Allan Iron & Welding Wks., Inc., 133 Murray St., Rochester, N. Y.
Jones, Edwin R. (C), Allan Iron & Welding Wks., Inc., 133 Murray St., Rochester, N. Y.

ST. LOUIS

Clements, George W. (C), 1343 McCutcheon Blvd., Richmond Hgts., Mo.
Cyrus, John H. (C), 2762 McCausland, St. Louis, Mo.
Grainger, B. J. (D), 1306 W. Main, Belleville, Ill.
Jablonsky, Roy D. (C), 824 N. Price Rd., Clayton, Mo.
Locker, Robert (C), 1421 Blackstone, St. Louis, Mo.
Parson, Harry E. (B), Aluminum Ore Co., 3300 Missouri Ave., E. St. Louis, Ill.

SAN FRANCISCO

Daley, Harry (D), 563 Oakland Ave., Oakland, Calif.
Smith, Richard E. (B), 2174 Calif. St., San Francisco, Ill.
Strom, D. W. (B), Western Pipe & Steel Co. of Calif., 200 Bush St., San Francisco, Ill.

SOUTH TEXAS

Ballew, R. T. (D), 5138 Leeland Ave., Houston, Texas.
Bock, L. E. (C), 110 Haywood Dr., Houston, Texas.
Doyle, George B. (C), 4313 Jefferson St., Houston, Texas.
Eberle, Frank, Jr. (D), 309 N. Bryan, Houston, Texas.
Hamman, George T. (D), 1502 Vasser St., Houston, Texas.
Lawson, G. W. (C), Rt. 10, Box 2431, Houston, Texas.
Porter, H. P. (C), 314 King St., Houston, Texas.

Schild, William (C), Bell School of Welding, 3108 Navigation Blvd., Houston, Texas.

WESTERN NEW YORK

Schliecker, Louis H. (C), R. C. Neal Co., Inc., 569 S. Clinton St., Syracuse, N. Y.

YORK

Bingaman, Roy E. (C), 645 W. Locust St., York, Pa.
Farcht, Thomas (D), Alloy Rods Co., York, Pa.
Groff, Ernest W. (D), R. D. 1, Manchester, Pa.
Heisey, Paul B. (D), R. D. 1, Elizabethtown, Pa.
Huebner, Edward J. (D), 257 E. Water St., Middletown, Pa.
Jones, Loyal R. (D), Maryland Line, Maryland.
Waltimyer, Marion H. (D), 1523 N. George St., York, Pa.

YOUNGSTOWN

Edwards, G. M. (C), 2305 Burton St., S. E., Warren, Ohio.
Gordon, Joe (D), Youngstown Welding & Eng. Co., Youngstown, Ohio.
Hripko, John S. (D), 135 Millett Ave., Youngstown, Ohio.
Kersey, Charles R. (D), 851 Marshall St., Youngstown, Ohio.
Wyman, John W. (D), 1321 Charlotte Ave., Youngstown, Ohio.
Zamaria, Geo. (D), 115 N. Evanston Ave., Youngstown, Ohio.

NOT IN SECTIONS

Clarke, Edward J. (B), Murex Welding Processes, Ltd., Waltham Cross, Herts, England.
Frederick, Leo P. (D), 7211 N. Atlantic Ave., Portland, Oregon.
Gibbs, Arthur E. (D), 1925 N. E. Knott St., Portland, Oregon.
Green, Weldon W. (D), Rt. 11, Box 690, Phoenix, Arizona.
Heil, Luke (D), 2119 Marshall St., Benwood, W. Va.
Johnson, Leon H. (A), Struthers Wells-Titusville Corp., Warren, Pa.
Knupple, Fred (D), Otoe, Nebraska.
Welch, J. L. (C), H. K. Ferguson Co., 1306 Metropolitan Ave., Dallas, Texas.
Wolk, Leon (D), Air Corp Technical School, 32nd School Sqdn. Chante Field, Bldg. 133, Rantoul, Ill.

A WELDER'S PRAYER

Furnished through the courtesy of William Newton, a welder who apparently has spent his share of time in welding galvanized inner bottoms of ships.

"Dear Lord"

"This morning I shall pray,
That this will be the perfect day.
That I will get to work on time,
And just for once I'll find my line.
Let me have no cause to fume and fret,
Because my gloves are soaking wet.
Keep the blower running fine and dandy
And let's have no rewelds from Andy.
Let me have no trouble with line or light.
Please give me fits that are nice and tight;
And then:
Oh Lord, I'll give thee thanks,
For a perfect day in the Galvo Tanks."

SQUARE D CO. LAB.

The establishment of a research laboratory by Square D Company at its Elmhurst, N. Y., plant to carry on a program of intensive research and development work encompassing the activities of the entire company was announced by F. W. Magin, president, in their annual report. The company is a manufacturer of electrical equipment and aircraft precision instruments.

IRA T. HOOK

Ira T. Hook, past chairman of the Connecticut Section, has obtained leave from his post as Research Engineer for The American Brass Company at Ansonia to act for the "duration" as Senior Instructor in the armored Force School, Tank Division, Fort Knox, Kentucky. Mr. Hook has helped in the writing of several chapters in the forthcoming second edition of the Welding Handbook dealing with the metallurgy and welding of the copper alloys.

MEMBERSHIP ACTIVITIES

New York takes the lead for the month of January in having secured 24 new members of which 12 were Associates, 10 Operating, and 2 Student Members. A close second is the Northern New Jersey Section with 19 new members, 18 of them Operating Members and the other an Associate Member.

The Detroit Section has the honor of securing the largest number of Members—4.

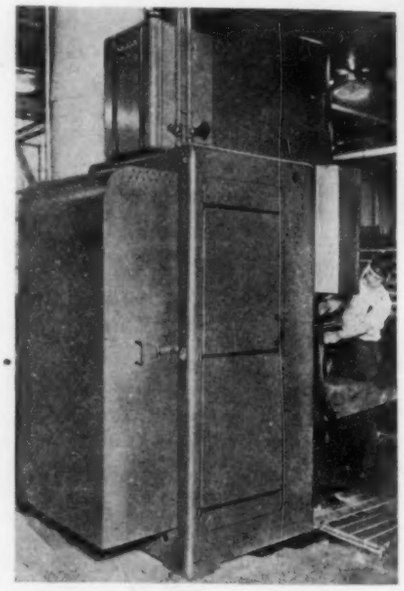
Philadelphia enters the honor role this month through securing 1 Sustaining Member, 1 Member, 4 Associate Members and 4 Operating Members.

G-E BREAKERS FOR COORDINATED WELDING MACHINE DESIGN

Air circuit breakers which can be incorporated as an integral part of resistance welding machines by their manufacturers are now available from the General Electric Company. In most cases heretofore, welding machines have been sold without a protective device, and it has been up to the purchaser to add one to the equipment. The present trend is toward the coordination of the protective, and also control and timing, devices in the welding machine as standard equipment.

G-E's breakers offered for the purpose are designated Types AE-1AY1 and AE-1BY1. They are metal-enclosed and can fit behind the steel panels of the welder. The breakers can be removed easily for inspection by unscrewing two screws in the breaker case. Power is entirely disconnected from the breaker when it is removed, providing complete safety for the inspection.

The breakers have a wide range of calibration, offering a choice of trip settings which provide full protection and still allow maximum output of the tube. They can be arranged to open the circuit in case of undesirable conditions such as "low-voltage" or no "water flow," and also to close the circuit remotely by means of a push button. They dispense with



tube replacements and respond immediately to reduce tube failure and minimize burning of material.

Annual Meeting

DETROIT

October 12-16, 1942

Members desiring to present papers or knowing of the availability of such papers are requested to send in their suggestions not later than April 1st to

W. Spraragen
American Welding Society
33 West 39th Street
New York, N. Y.